# SCIENCE

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## *THE IONS OF ELECTROLYSIS.**

THE subject of electrolysis must always have a special interest for the Royal Institution. It was here that Davy showed its practical value by his brilliant discovery of the metals of the alkalies and alkaline earths; and it was here that Faraday laid the foundation of the scientific discussion of electrolysis; it was here that with his singular experimental skill and clearness of insight he discovered and expounded the laws of electrolysis which will always be known by his name. It is therefore with a good deal of diffidence that I stand here to continue the story. And there is much to be said, for, like all good work, Faraday's work has been fruitful, and in consequence of it, as well as of the genius and skill of subsequent investigators, we now know much about electrolysis which Faraday did not and could not know.

The great difficulty left was that of the mechanism of electrolysis. That the cation and the positive electricity travel together towards the cathode, and that the negative electricity similarly travels with the anion towards the anode, and that on their arrival at the electrodes the electricity is delivered to the metallic conductor and the matter is set free to appear as the ion itself, or to break up, or to act on the elec-

* Lecture given before the Royal Institution of Great Britain.

trode, or on the solvent, or on something present in the solution; that the quantity of each ion so set free is proportional to the quantity of electricity transferred from the one electrode to the other and to the equivalent of the ion—that is, as we would put it now (if purists will allow us to speak of the *atomic* weight of $NH_4$ or of $NO_3$), to the atomic weight of the ion divided by its valency; all that was made out by Faraday. He had made some way in finding out how the liberated ions act, when they do act, on the things in the presence of which they find themselves; and where he led, others have followed, so that we have now many electrolytic methods of oxidation, of reduction and of synthesis, and great manufacturing industries depending on electrolysis. On this large field I do not now purpose to enter. What I wish to call your attention to this evening is the mechanism of electrolysis, or perhaps I should say the progress that has been made towards an explanation of the phenomena.

The earlier theories, from Grotthuss* in 1806, all assume that the decomposition is caused by the attraction of the electrodes or by the passage of the current, and that a definite electromotive force, different for each electrolyte, is required in order that decomposition shall take place. According to these theories, if the electromotive force is below that definite minimum no decomposition can occur and no current can pass.

And indeed at one time it was supposed that this was so. But Faraday, in a series of ingeniously devised and carefully executed experiments, showed that with electromotive force below the minimum necessary for the production of bubbles of gas on the electrodes, a perceptible current could pass for many days. He supposed that this small current was due to non-electrolytic conduction by the electrolyte. But the study of the phenomena of the polarization of the electrodes led ultimately to the complete explanation by Helmholtz* in 1873 of this apparently metallic conduction by the electrolyte, and to a proof that any electromotive force, however small, sends a current through an electrolyte and gives rise to separation of the ions proportional to the amount of electricity transmitted.

The phenomena of the polarization of the electrodes may be described shortly as follows: In the electrolysis of water (or rather of dilute sulphuric acid) it had been observed so long ago as 1802 that platinum or silver plates which had been used as electrodes acquired peculiar properties, so that for a short time the plate that had been the anode acted like the silver, and the plate that had been the cathode like the zinc of a voltaic cell, producing a short-lived and rapidly diminishing current. This observation was first made by Gautherot,† a teacher of music in Paris, who notes the effect of the current on the tongue and states that he had succeeded in decomposing water by means of his apparatus. Shortly after, J. W. Ritter, apparently without knowing anything of Gautherot's work, made a great many observations on the same subject. I cannot refrain from reading to you a passage from a letter from Christoph Bernoulli to van Mons. I take it from the translation published in *Nicholson's Journal*, October, 1805: "As Mr. Ritter at present resides in a village near Jena, I have not been able to see his experiments with his grand battery of two thousand pieces, or with his battery of fifty pieces, each thirty-six inches square, the action of which continues

* Grotthuss, *Annales de Chimie*, LVIII., p. 54 (1806).

* Helmholtz, *Pogg.*, 150, p. 483 (1873); Faraday Lecture, *Chem. Soc. Trans.*, 39, p. 287 (1881); *Wied.*, 34, p. 737 (1888).

† Gautherot, *Annales de Chimie*, XXXIX., p. 203 (1801).

very perceptible for a fortnight. Neither have I seen his experiments with the new battery of his invention, consisting of a single metal, and which he calls *the charging pile.*

"I have frequently, however, seen him galvanize louis-d'or lent him by persons present. To effect this, he places the louis between two pieces of pasteboard thoroughly wetted, and keeps it six or eight minutes in the chain of circulation connected with the pile. Thus the louis becomes charged, without being immediately in contact with the conducting wires. If this louis be applied afterwards to the crural nerves of a frog recently prepared, the usual contractions will be excited. I had put a louis thus galvanized into my pocket, and Mr. Ritter said to me a few minutes after, that I might find out this louis from among the rest, by trying them in succession upon the frog. Accordingly I made the trial, and in reality distinguished among several others a single one in which the exciting quality was very evident. This charge is retained in proportion to the time that the piece has remained in the circuit of the pile. It is with metallic discs charged in this manner, and placed upon one another with pieces of wet pasteboard alternately interposed, that Mr. Ritter constructs his charging pile, which ought, in remembrance of its inventor, to be called the *Ritterian pile.* Mr. Ritter made me observe that the piece of gold galvanized by communication exerts at once the action of two metals, or of one constituent of the pile; and that the half which was next the negative pole while in the circle became positive, and the half toward the positive pole became negative."

Brugnatelli* suggested that the polarization of the plate which during the electrolysis had given off hydrogen was due to a compound of hydrogen with the metal of the electrode. But it was not until Schönbein discussed the question in 1839* that a systematic attempt was made to settle it by experiment. Schönbein's results were in favor of the view that the polarization is due to the formation on the surfaces of the electrodes of thin sheets of the products of the electrolysis.

Now the old theories assume that if we begin with very small electromotive force and gradually increase it, we have at first a state of tension, the electromotive force, so to speak, pulling at the ions, that this tension increases as the electromotive force increases till it becomes sufficient to pull the ions apart. If this were so there should be no current and no electrolysis till the electromotive force reaches a certain amount, and then suddenly a very great current and something like an explosive discharge of gas; for many molecules would be in the very same state of tension and all would give way at once.

When the electrolytic decomposition of water was first observed, as it was (by Nicholson and Carlisle) immediately after the publication of Volta's first description of the pile, the great difficulty felt by every one was that the hydrogen and the oxygen came off at different places which might be far apart. Grotthuss's theory no doubt explained this, but after the proof of a cause of polarization given by Schönbein, and the accumulating evidence that Ohm's law applies to electrolytic as well as to metallic conduction, no one could hold or defend Grotthuss's theory, although it was retained as a sort of makeshift until some one could think of something better. The something better was produced by Clausius in 1857.† Clausius was one of the eminent physicists to whom we owe the

* Brugnatelli, *Gilbert's Annalen*, XXIII., p. 202 (1806).

* Schönbein, *Pogg.*, XLVI., p. 109; XLVII., p. 101 (1839).

† Clausius, *Pogg.*, ci, p. 338 (1857).

kinetic theory of gases, and his theory of electrolysis is derived from an application to solutions of the ideas involved in this kinetic theory. He supposes that the molecules of the electrolyte move through the solution as the molecules of a gas move, that they collide with one another as the gas molecules do, and that it must happen that here and there ions get separated and remain separated for a time, cation again uniting with anion when two of them meet under favorable conditions. There will thus always be some detached ions moving about just as molecules do. They will not always be the same ions that are thus detached, and a very small proportion of such loose ions will suffice to explain the phenomena. These loose ions retain in their separate condition the charges of electricity which they had when united, the cations being positively and the anions negatively charged. This is assumed to be the state of matters in any solution of an electrolyte. If now into such a solution we place two electrodes with any, however small, difference of potential, the cathode, being negative, will exercise an attraction upon the positively charged cations, and the positive anode will exercise a similar attraction on the negatively charged anions, and thus the loose ions, which before the introduction of the electrodes moved about in the liquid with no definite preferred direction, will on the whole, now that the electrodes have been introduced, move preferably, the cations towards the cathode, and the anions towards the anode, and those which are near the electrodes will be drawn to them and discharge their electric charge. This theory seems therefore to explain the phenomena. The essential difference between it and all previous theories is that Clausius does not attribute the decomposition to the current or to the attraction of the electrodes; what the attraction of the electrodes does is to separate the ions already disengaged from one another, and this the smallest electromotive force can do. The theory is so far adequate, but is it admissible? Can we suppose that hydrogen and chlorine atoms can move uncombined through the solution? It is to be noted that while Clausius does not give any opinion as to the proportion of loose ions to the total ions in any case, he assumes that this proportion increases as the temperature rises, on account of the greater briskness of the movements of the particles, and points out that this is in accordance with the fact that electrolytes conduct better as the temperature is higher. But he says, 'to explain the conduction of the electricity it is sufficient that in the encounters of the molecules an exchange of ions should take place here and there, and perhaps comparatively rarely.'

In this connection we may look at the views expressed by Williamson in his paper on the theory of etherification.* He says: "We are thus forced to admit that in an aggregate of molecules of any compound there is an exchange constantly going on between the elements which are contained in it. For instance, a drop of hydrochloric acid being supposed to be made up of a great number of molecules of the composition ClH, the proposition at which we have just arrived would lead us to believe that each atom of hydrogen does not remain quietly in juxtaposition with the atom of chlorine with which it first united, but, on the contrary, is constantly changing places with other atoms of hydrogen, or, what is the same thing, changing chlorine." Williamson founded this opinion on the observed facts of double decomposition. He made no application of this view to the case of electrolysis, and indeed does not explicitly mention the temporary detachment of the atoms during the process of ex-

* Williamson, *Chem. Soc. Journ.*, IV., p. 111 (1852).

change; this is wholly due to Clausius, who arrived at his views as to the exchanges going on in a solution in a way quite different from that followed by Williamson, and quite independently. It was not then known how closely double decomposition and electrolysis are connected. We may perhaps get a clearer idea of Clausius's theory by imagining the phenomenon to take place on a scale such that we could see the individual ions. Let us then imagine a large field with a large number of men in it, each mounted on a horse. We shall further suppose that all the men are exactly alike and that all the horses are exactly alike. They are moving at random, most of them at about the same rate, but a few of them faster, a very few of them considerably faster, a few of them slower, a very few of them considerably slower, than the average. They move in straight lines until they meet an obstacle which makes them deviate. This obstacle will often be another man and horse. The collision will give both a shake, and will sometimes dismount one or both of the riders. When this happens each will look for a horse, and as all horses are exactly alike, the horse such a dismounted man finds and mounts will not always be the one he came down from. But in any case there will be always in the field some men without horses and some horses without men. And the quicker the average pace the larger will be the proportion of dismounted men and riderless horses to the total number of men and horses. And this not only because there will be more and, as a rule, more violent collisions, but also because the dismounted men will have more difficulty in catching horses, although to keep up the analogy of the ions we must suppose the horses to be as anxious to be caught as the men are to catch them. If it does not make my allegory too grotesque we might suppose places with attractions for men and for horses, respectively, to correspond to the electrodes, so that a man looking for a horse would on the whole rather go in the direction of lunch than away from it, and if he got near the refreshment room before he found a horse, he would look in there. An objection was made to Clausius's theory that the same thing which he supposed to happen in solution, say of hydrochloric acid, ought also to happen in the gas. We are not yet in a position to discuss this point with much prospect of obtaining a perfectly satisfactory explanation of the difficulty, although some progress towards an intelligible theory has been made, but at the risk of being tedious I may indicate that my allegory may show us that we need not despair of finding in due time an answer. Let us suppose that in the field there are not only men and horses, but also a large number of other moving objects, let us say, by way of example, cows. It seems plain that whether the presence of the cows would increase the chance of a man being dismounted or not, it would sensibly interfere with his chance of catching a horse if he were. And it will be admitted that the nature and size of these other moving objects must exercise an influence on the proportion of horseless men and riderless horses to the total number. But these other moving objects represent the molecules of the solvent, so that we need not be surprised when we find that the electrolytic conductivity is affected by the nature of the solvent and that where there is no solvent the conductivity is very small or even nothing.

A very important question was left only partially answered by Faraday. It is, What substances are electrolytes? Faraday considered the water in dilute acid as the electrolyte, and the acid as a substance having the power of increasing the conductivity of the water. When a solution of sulphate of copper was electrolyzed, he

supposed that the water was primarily decomposed and that the metallic copper was a secondary product reduced by the nascent hydrogen. He says:* "I have experimented on many bodies, with a view to determine whether the results were primary or secondary. I have been surprised to find how many of them, in ordinary cases, are of the latter class and how frequently water is the only body electrolyzed in instances where other substances have been supposed to give way." From our present point of view many of us would rather say that the direct electrolysis of water very rarely occurs, except to a very small extent.

In 1839 Daniell began a series of ingeniously devised and skillfully executed experiments with the view of determining, in the case of salt solutions, whether it is the salt or the water which is primarily electrolyzed. The results appeared in two letters from Daniell to Faraday in 1839† and 1840,‡ and in a paper by Daniell and W. A. Miller in 1844,§ all published in the *Transactions of the Royal Society*. The purpose of these investigations was attained, and it was completely proved that in reference to their behavior as electrolytes there was no difference between say potassium chloride and potassium nitrate, except that in the latter some ammonia was formed at the cathode by the reducing action of the nascent hydrogen, and it was clearly shown that from an electrolytic point of view all the oxygen acids and their salts fell into line with hydrochloric acid and the chlorides, and the $NH_4$ was electrolytically perfectly analogous to K. There is, however, an interest in these papers beyond this important result. In the earlier part of the work the authors measured the amount of electrolysis not only by 'the amount of ions disengaged at either or both electrodes by the primary action of the current or the secondary action of the elements,' but also tried to obtain a check to this way of measuring, by using a diaphragm in the electrolytic cell, and analyzing the contents of the two parts of the cell, the one on the anode side and the other on the cathode side of the diaphragm. This check was 'founded on the hypothesis that the voltaic decomposition of an electrolyte is not only effected by the disengagement of its anion and cation at their respective electrodes, but by the equivalent transfer of each to the electrodes, so that the measure of the quantity of matter translated to either side of the diaphragm might be taken as the measure of the electrolysis.' They soon found that this hypothesis was unfit to give any such measurement, and in the paper of 1844 state that their results show that the hypothesis of equivalent transfer of the ions, 'although generally received, is itself destitute of foundation.'

The non-equivalent transfer of the ions, incidentally observed by Daniell and Miller, and imperfectly measured by them in a few cases, was made the subject of a long and elaborate series of experiments by Hittorf. The work extended over six years from 1853 to 1859* and is a monument of patient labor and of happy adaptation of means to a clearly perceived end. The importance of the work was not at first recognized by either physicists or chemists; indeed its meaning was scarcely understood. I shall try to put before you as shortly as I can an outline of the ideas involved in the work, and of the most important conclusions arrived at by Hittorf. As the anions and the cations are separated at their re-

* Faraday, 'Experimental Researches in Electricity,' par. 751 (1834).

† Daniell, *Phil. Trans.*, 1839, p. 97.

‡ *Op. cit.*, 1840, p. 209.

§ Daniell, *Phil. Trans.*, 1839, p. 97.

* Hittorf, *Pogg.*, LXXXIX., p. 177 (1853); XCVIII., p. 1 (1856); CIII., p. 1 (1858); CVI., pp. 337 and 513 (1859). *Arch. Néerland.* (II.), VI., p. 671 (1901).

spective electrodes in equivalent quantity, that is, in the case where the valency of anion and cation is the same, in equal numbers, it never occurred to any one to doubt that they traveled towards the electrodes at the same rate, until Daniell and Miller showed that this hypothesis is erroneous. To follow their reasoning and that of Hittorf we may take an imaginary case, and suppose an electrolyte $MX$ with its cation $M$ and its anion $X$ of such character that these ions when separated at the electrodes can be removed from the solution completely and at once, and that the electrolysis is carried on in a vessel provided with two compartments, one containing the cathode and the other the anode, such that whatever happens at an electrode shall affect only the contents of the compartment containing that electrode, and so arranged that the liquid contained in each compartment can be completely removed from it and analyzed. Now, let us first suppose $MX$ to be such that its ions travel at the same rate. In the time then in which one $M$ has entered the cathode compartment one $X$ has left it. There is at this moment an excess of two $M$'s in this compartment; these are deposited at the cathode, and now the concentration of the solution in this compartment is diminished by one $MX$. Similarly at the anode during the same time one $X$ has entered and one $M$ has left, two $X$'s have been deposited and the solution has lost one $MX$. In this case, then, where the two sets of ions travel at the same rate, the loss of solute is the same at the two electrodes. Let us now suppose an extreme case in which one of the sets of ions (say the cations) does not travel at all. In the time in which one $X$ leaves the cathode compartment no $M$ enters it, the excess of one $M$ is deposited, and the solution here has lost one $MX$. At the anode one $X$ has entered and no $M$ has left, the $X$ is deposited, and the solution here has lost no $MX$. Again, take the case that the anions travel twice as fast as the cations. Here in the time in which one $M$ enters the cathode compartment two $X$'s leave it, the excess of three $M$'s is deposited, and the solution has lost two $MX$'s. At the anode during the same time one $M$ has left and two $X$'s have entered, the three $X$'s have been deposited and the solution has lost one $MX$. Of course it will be seen that the excess of one kind in a compartment consists not only of what enters it, but also of the excess resulting from the departure of the other kind. Without taking any more cases we at once see that the speed of the cation is to that of the anion as the loss of solute at the anode is to that at the cathode. This non-equivalent transfer has sometimes been described in another way. It has been said that the ions go at the same rate, but that at the same time the solute as a whole is being moved towards one of the electrodes. But this really is the same thing. If we imagine two processions walking with the same length of step and the same number of steps a minute in opposite directions on such a moving platform as that in the Paris Exhibition, we might no doubt say that the two *walked* at the same rate; they could not be said to *travel* at the same rate. Hittorf's way of putting it is not only the simpler way, it is the only way that agrees with what has since been made out as to the rate of movement of the ions.

Hittorf's work had to wait long for recognition, but we now know its great importance, not only on account of the large number of accurate measurements, but also because of the general conclusions he drew from them. He deduced from the transfer numbers conclusions as to the nature of the solute, showing, for instance, that solution of stannic chloride electrolyzes as hydrochloric acid, the stannic chloride being completely hydrolyzed. He also showed that such double salts as KCN,AgCN, 2KCl,-

$PtCl_4$ and $KCl,AuCl_3$ have potassium for their only cation, the silver, the platinum and the gold forming part of the anion. He also showed that $2KI,CdI_2$ behaves as a single salt with K as cation when the concentration is great, but as two salts with cadmium as well as potassium as cation in dilute solution. In these and in similar cases, Hittorf made a valuable contribution to the theory of double salts. But perhaps the most striking generalization is that contained in the words 'electrolytes are salts,' and his very instructive comparison of the readiness with which a substance enters into double decomposition and the readiness with which it can be electrolyzed. With the fairness to his predecessors which is characteristic of him, he quotes an almost forgotten statement of Gay-Lussac to something like the same effect.

Ladies and Gentlemen,—I wish here to tell you that within the last three weeks Professor Hittorf entered on the fifty-first year of his professorship. The officials of the Royal Institution have authorized me to ask our Chairman, Lord Kelvin, to send your congratulations to Professor Hittorf on his jubilee.

We now come to another turning-point in the development of the theory of electrolysis, inseparably associated with the name of Kohlrausch.* It is to Kohlrausch and to those who worked with him that we owe the methods for the accurate determination of the conductivity of electrolytes. I need not give a description of the apparatus. It is now used in every laboratory, and by means of it a series of observations of the conductivity of an electrolyte can be made at different concentrations in a very short time. An early result of Kohlrausch's investigation was his discovery that 'all acids which have been examined in strong solutions show, for a definite proportion of water, a maximum of conductivity,' and he shows that for many other electrolytes there is a solution which conducts better than one either a little more or a little less concentrated. Thus the maxima of conductivity of the following acids are at the following percentages: $HNO_3$, 29.7 per cent.; HCl, 18.3 per cent.; $H_2SO_4$, 30.4 per cent.; $HC_2H_3O_2$, 16.6 per cent. "The maximal acetic acid conducts at least 38,000 times better than concentrated acetic acid." In connection with this he says, 'we do not know one single liquid which at ordinary temperature is, by itself, a good electrolytic conductor.' He refers the trace of conductivity in $H_2SO_4$ to the dissociation into water and $SO_3$ observed by Marignac and by Pfaundler, and observes that, as up to the present time we know only mixtures which at ordinary temperature conduct well, the supposition is not unnatural that it is mixture that makes electrolytes good conductors. And again, if what has been said is correct, we must, in order to have good conduction, protect the wandering constituents from frequent meeting with one another, and this service is performed by the solvent, which makes it possible for the ions to get over a part of their journey—and so much larger a part the more solvent there is—without reforming molecules. It is this suggestion which I ventured a little while ago to put into an allegorical form.

In order to compare the conductivity of one electrolyte with that of another, it is necessary that we choose comparable quantities of the two, and there is no difficulty in seeing that such comparable quantities are those decomposed by the same current of electricity—that is to say, the electro-chemical equivalents of the

* Kohlrausch and Nippoldt, *Pogg.*, CXXXVIII., p. 280 (1869); Kohlrausch, *Pogg.*, Jubelband, p. 290 (1874); Kohlrausch and Grotrian, *Pogg.*, CLIV., pp. 1 and 215 (1875); Grotrian, CLVII., p. 130 (1876); Kohlrausch, CLIX., p. 233 (1876). *Göttinger Nachrichten*, 1876, p. 213. *Wied.*, VI., p. 1 (1879); XI., p. 653 (1880).

electrolytes. Accordingly, instead of expressing the concentration in percentage of the solute, Kohlrausch uses 'molecular numbers.' The molecular number of a solution is the quantity, in grams, of the solute contained in a liter of the solution divided by the equivalent of the solute. Dividing the conductivity of a solution by its molecular number gives its molecular conductivity. It will be seen that 'molecular' is not used here in its ordinary chemical sense, but as the meaning is quite distinctly stated no confusion need arise. Kohlrausch showed that the molecular conductivity increases as the solution becomes more dilute, and with extreme dilution approaches a constant value.

I now show an experiment to illustrate this.

The apparatus* consists of an electrolytic cell in the form of a tall rectangular trough, the back and front being broad plates of glass, while the sides are composed of narrow strips of wood completely lined with silver-foil. The bottom of the cell is made of non-conducting material. The two sheets of silver serve as electrodes, being connected to binding screws by means of external wires. The cell is introduced into a battery circuit along with a galvanometer of low resistance. If the cell be filled with pure water there is scarcely an appreciable current transmitted. On removing the water and pouring in 20 c.c. of a 4-normal silver nitrate solution, so as to cover the bottom to a depth of a few millimeters, a current passes as indicated by the galvanometer. If pure water be now added in successive portions and the solution stirred after each addition, an increase in the strength of the current is observed, the increase being greatest after the first dilution, and becoming less with each succeeding dilution, so that a maximum is approached. In this experiment the distance between the electrodes is constant, and the area of the electrodes and of the cross-section of the conducting solution is proportional to the volume of the solution, and the quantity of the salt is constant; therefore any change in the strength of the current means a corresponding change in the molecular conductivity of the dissolved salt. The molecular conductivity, therefore, increases with the dilution, and asymptotically approaches a maximum.

I cannot here enter into a description of the great experimental difficulties connected with the determination of the conductivity of extremely dilute solutions, but I may refer to one of them, namely, the small but variable conductivity of the water used in preparing the solutions. There seems now to be no doubt that water is in itself an electrolyte. But the purest water that has been obtained has a conductivity of only about $10^{-10}$ as compared with that of mercury as unit. The minutest traces of salts greatly increase the conductivity, so that ordinary distilled water has a conductivity of $3 \times 10^{-10}$ or more. With solutions of moderate dilution the variation of this very small quantity is of little consequence, but with extremely dilute solutions the conductivity to be measured is of the same order as that of the water.

For our present purpose the most important conclusion drawn by Kohlrausch from his observations is his law of the independent rate of motion of the ions in dilute solutions. The rate of motion of any ion towards the electrode depends on the gradient of potential. But Kohlrausch shows that the rate of motion of each ion in dilute solution is proportional to a number, the same whatever be the other ion of the electrolyte. Thus the rate at which the cation K moves towards the cathode in dilute solution is the same in solutions

* From a paper by Noyes and Blanchard, in the *Zeitschrift für physikalische Chemie*, XXXVI., p. 9 (1901).

of KCl, $KNO_3$, $KC_2H_3O_2$, etc. Kohlrausch gives these numbers for six cations and ten anions. The results calculated from these numbers agree well with the observed conductivities.

Methods have been devised for directly observing and measuring the rate at which ions travel. In this connection I may specially mention the names of Oliver Lodge, Whetham and Masson. These measurements agree very well with the rates calculated by Kohlrausch.

I now show an experiment indicating a way in which such measurements can be made.

The apparatus* consists of a glass U-tube, with a long stopcock-funnel connected to the lower part of it. The tube is nearly half filled with a dilute (about 0.03 per cent.) solution of potassium nitrate, and then about the same quantity of a solution of potassium permanganate, of the same conductivity as the other solution, is slowly introduced by means of the funnel. The permanganate solution is loaded with urea (a non-electrolyte) so as to make it denser than the nitrate solution; the permanganate solution now lies in the lower part of the U-tube with a sharp interface between it and the nitrate solution above it in each limb of the tube. If now we connect the electrodes, which were preliminarily inserted into the upper parts of the limbs of the tube, with a battery with high difference of potential, a current will pass, and a transference of ions will take place, cations (K) towards the cathode and anions ($NO_3$ and $MnO_4$) towards the anode, and the column of pink color will rise in the limb containing the anode and fall by an equal amount in the other. By this means an approximation can be made to the rate of travel of the ions.

We now come to a new chapter beginning with 1887; but before entering on it we must turn aside for a little to a subject which does not at first sight seem to have a very close relation with the matter we have in hand. The subject is that of what may be called the osmotic phenomena. These are all connected with the concentration or with the dilution of solutions. They all involve the idea of the work done in concentrating a solution. We need not discuss the theory of these phenomena, we are interested in them now only as they give us methods of ascertaining the molecular concentration of a solution. In 1883* Raoult showed that in the case of a great many substances, equimolecular solutions (with the same solvent) have the same freezing-point In 1886† he showed that equimolecular solutions with the same volatile solvent have the same boiling-point. Molecular is here used in its ordinary chemical sense. These discoveries were eagerly taken up by chemists as promising an important addition to the means at their disposal for determining the molecular weights of substances. Convenient arrangements for applying the methods were devised by Beckmann,‡ and soon came into use in nearly every laboratory. They were almost exclusively used for the determination of the molecular weight of organic substances, and have been found trustworthy in such cases. When, however, van't Hoff§ in his study of the theory of solutions concluded from theoretical considerations that the depression of the freezing-point and the rise of the boiling-point are proportional to

* Experiment from a paper by Nernst, in the *Zeitschrift für Elektrochemie*, III., p. 308 (1897).

* Raoult, *Compt. rend.*, XCIV., p. 1517; XCV., pp. 187 and 1030 (1882); XCVI., p. 1653; XCVII., p. 941 (1883).

† Raoult, *Compt. rend.*, CIII., p. 1125 (1886); CIV., pp. 976 and 1430; CV., p. 857 (1887). *Zeitschrift f. physik. Chemie*, II., pp. 353 (1888).

‡ Beckmann, *Zeitschrift f. physik. Chemie*, II., pp. 638 and 715 (1888); IV., p. 532 (1889); VIII., p. 223 (1891).

§ van't Hoff, *Zeitschrift f. physik. Chemie*, I., pp. 500–508 (1887).

osmotic pressure in the case of dilute solutions, the observations made by Raoult and others furnished a number of facts ready for testing the theory. He found that, while in many cases the osmotic pressure calculated from his formula $PV=RT$ agreed, within the limits of experimental error, with the value calculated from the observation, there were a very considerable number where the observed value differed from that given by the formula. He accordingly modified the formula by the introduction of a factor $i$, so as to make it $PV=iRT$. This factor $i$ is unity in the cases where observation by Raoult's method gives results agreeing with the formula $PV=RT$; in other cases it is greater or less than unity, and indicates the extent of the disagreement. Arrhenius, to whom van't Hoff showed these numbers, pointed out that all the substances which had $i$ greater than unity were electrolytes, and that the deviation had to do with their splitting up into ions. Arrhenius* had before this time (1887) been working at the subject of electrolysis and of the relation between the readiness with which substances undergo electrolysis and the readiness with which they enter into chemical reactions. He had been looking for an explanation of the fact that the conductivity of a solution of an electrolyte is not proportional to its concentration, and had come to the conclusion that this must depend on some of the molecules of the solute being 'active,' that is, taking part in the conduction—while others were inactive, behaving like molecules of a non-electrolyte, and that the proportion of active molecules increases with dilution.

van't Hoff's factor $i$ enabled Arrhenius to give precision to these ideas, and in 1887† he formulated the theory that the 'active' molecules were those which were split into ions. It was now possible to calculate $i$ in two ways and compare the results. Arrhenius gives a list of eighty-four substances, for which there existed at that time data for such calculations, and, calculating the value of $i$ as deduced on his new theory from the conductivity, compares it with the value of $i$ derived from freezing-point observations in each of the eighty-four substances. The agreement does not at first sight strike one as very close, but there are several circumstances which have to be considered in judging them. The whole mass of published observations was taken, the limits of probable error are very different in different cases, and the freezing-point measurements were all made at temperatures a little below 0°, while the conductivity measurements were made at 18°. The comparison was made, not as a demonstration of the theory, but rather as a preliminary trial with such materials as were at hand. The real testing of the theory necessarily came later. So I think we may agree with Arrhenius that, considering all the circumstances, the agreement is not unsatisfactory, except in the case of nine of the substances, and that most of these nine cases are liable to suspicion on other grounds. In 1887, almost at the time when Arrhenius published the paper of which I have just been speaking, Planck* discussed the subjects of the diminution of the vapor pressure and the lowering of the freezing-point in dilute salt solutions from the thermodynamic point of view, and starting from the principle of the increase of entropy, deduced formulæ connecting these quantities with the molecular weight. He says, in conclusion: "This formula claims exact numerical validity. It gives for most substances a greater molecular number than that usually assumed, *i. e.*, a partial or complete chem-

* Arrhenius, *Bihang till kongl. Svenska vetensk. Akad. Handlingar*, 1884, Nos. 13 and 14.

† Arrhenius, *Zeitschrift f. physik. Chemie*, I., p. 631 (1887).

* Planck, *Wied.*, XXXII., p. 495 (1887).

ical decomposition of the substance in the solution. Even if the consequences of this proposition should require an essential modification of the generally prevailing views as to the constitution of solutions, I do not know any fact which shows it to be untenable. Indeed, many observations in other departments (the proportionally strong affinities of dilute solutions, which remind one of the properties of the nascent state, the easy decomposability by the weakest galvanic current, the phenomena of internal friction), are directly in favor of the view that in all dilute solutions a more or less complete decomposition of the molecules of the dissolved substances takes place. Besides, this conception adapts itself well to the opinions developed by L. Meyer, W. Ostwald and S. Arrhenius on the state of the molecules of dissolved substances, as it only goes a step further and fixes numerically the degree of the decomposition.''

An objection was taken to Planck's argument. It was said that as his formula contains the ratio of the molecular numbers of the solute and of the solvent, it could not be inferred that that of the solute is greater than its formula leads to, for it might be that the molecular number of the solvent is less than that indicated by its formula. Planck's answer was immediate and obvious. In any expression in which the molecular number of the solvent appears, there also appears as a factor the molecular weight. For instance, in the formula for the depression of the freezing-point the molecular number of the solvent is multiplied by the latent heat of one molecule of the solvent, and similarly in other cases. So that it makes no difference what molecular weight we assume for the solvent, and the use of its molecular number is merely a convenient way of expressing its quantity.

This increase in the number of the molecules, or splitting into ions, was called 'electrolytic dissociation.' It will be seen that it is what Lodge in 1885, in speaking of Clausius's theory, called dissociation. But while it has some obvious resemblances to the dissociation of a gas, there are very striking differences between the cases, and perhaps some of the difficulties in the way of the acceptance of the theory may have arisen from the use of the same word for two things differing so much. We need not, however, discuss the name, but it is well to look for a little at the essentially different nature of the things. This essential distinction consists in the products of the electrolytical dissociation being charged, the one set with positive, the other set with negative, electricity, so that, while in the body of the solution they can move about independently, they cannot be separated by diffusion as the products of the dissociation of a gas can. It is true that the quicker moving ions can, to a small extent, forerun the slower moving ions, and diffuse a little further into pure water or into a more dilute solution, as is shown by the fact that when two solutions of the same electrolyte of different concentration are in contact there is a difference of electric potential between them, but they cannot be separated to any weighable extent in this way. In order to separate from one another two gases uniformly mixed, a certain calculable amount of work has to be done, so that after a gas has been dissociated and wholly or partially converted into a mixture of the two gaseous products, some work has still to be done to get them separately. So it is also in the case of electrolytic dissociation; but while in the former case the decomposition work is the main thing, and the separation work very small, in the latter it is quite the other way. Here the heat of dissociation, that is, the work spent in decomposing the electrolyte into its ions, is small (indeed sometimes negative), while the work to be done to *separate* the

ions is always very much greater. Indeed we may quite correctly say that in most highly dissociated solution of hydrochloric acid the hydrogen and the chlorine are still very firmly united, not indeed atom to atom, but each atom of the one kind to all the atoms of the other kind within a certain distance from it. A man does not lose his money when he takes it out of his pocket and puts it into a bank. He does indeed lose his relation to the individual gold and silver coins, and does not know and does not care where these particular pieces of metal are, but he is interested in knowing that they or their like are at his command, and the same sort of work will be required to impoverish him whether his money is in the bank or in his pocket. (I assume, of course, that the bank of our present imagination cannot become insolvent.)

I have said that the test of the theory would come later. It has been going on since 1887, and if time would allow I could give you many cases in which deductions from the theory have been found to agree with close quantitative accuracy with experimental observations. I shall mention only the first, still among the most important, namely, Ostwald's determination of the affinity constants, and his application of Guldberg and Waage's principle to the ions. I could also give you instances in which there have been discrepancies, or apparent discrepancies, and show how in some of these cases the difficulties have been cleared up. The history of this theory has in fact so far been that of every useful theory, for it is in this way only that a theory does its work. I shall select two points for illustration, not because they are more important than others, but because I can illustrate them by means of experiments which do not occupy much time, and can be made visible in a large room. The first has reference to the question, What are the ions in the case of a dibasic acid? As $HNO_3$ gives as its ions H and $NO_3$ so we might expect $H_2SO_4$ to give 2H and $SO_4$. But we find that until the dilution has advanced to a considerable extent the ions of sulphuric acid are mainly H and $HSO_4$. This is quite in harmony with the chemical action of $H_2SO_4$, for, as every chemist knows, at moderate temperatures we have the action $H_2SO_4 + NaCl = HCl + NaHSO_4$, and the temperature has to be raised in order to get the action $NaHSO_4 + NaCl = HCl + Na_2SO_4$. In the first of these experiments we take as the electrolyte a concentrated solution of potassium hydrogen sulphate $KHSO_4$. This gives the ions K and $HSO_4$. The latter go to the anode and there, on being discharged, form persulphuric acid, or its ions, and potassium persulphate $K_2S_2O_8$, being sparingly soluble, crystallizes out. This is the method by means of which Dr. Marshall discovered the persulphates. The next experiment will illustrate the formation and discharge at the anode of the anion $SO_4$. We have here dilute sulphuric acid with which is mixed a little manganous sulphate $MnSO_4$. The ion $SO_4$ when discharged, adds itself to $2MnSO_4$ and forms manganic sulphate $Mn_2(SO_4)_3$, recognized by its red color. This, even in acid solution, is quickly hydrolyzed, giving insoluble manganic hydrate.

The other point I wish to illustrate is the application of Guldberg and Waage's principle to ions. Without entering into any general discussion of this question, I shall merely say that theory leads to the result that the addition of a soluble acetate to a solution of acetic acid diminishes the concentration of H ions, and so makes the solution less effectively acid. This was experimentally proved by Arrhenius in 1890,* by measuring the rate at which cane-sugar

* Arrhenius, *Zeitschrift f. physik. Chemie*, V., p. 1 (1890).

is inverted by acetic acid alone, and with varying quantities of sodium acetate added to it. But as such an experiment cannot be made visible to a large number of spectators at once, I thought of a way of showing the same thing, which, while not capable of the same degree of accuracy, would prove the principle qualitatively. I have here a solution of ferrous acetate to which I have added enough acetic acid to prevent the precipitation of ferrous sulphide on the addition of sulphuretted hydrogen. I add sulphuretted hydrogen; of course no precipitate is formed. I now add a solution of sodium acetate mixed with rather more than three equivalents of acetic acid, so as to make it plain that the effect is not due to the formation of an acid acetate, and you see that we have at once a precipitate of ferrous sulphide. To show that the addition of the water has not produced the result, I add to another portion of the same solution as much water, and you see that no precipitation takes place.

I have not spoken of non-aqueous solutions. At the rise of the dissociation theory, these were generally supposed to be non-conductors, but many of them have now been examined both by scientific workers in the old world, and very specially by our colleagues on the other side of the Atlantic, and have been found to conduct electrolytically. It seems likely that these investigations will throw much light on the influence of the solvent on the conductivity of the dissolved salt. Particularly interesting is the relation, indicated in some cases, between the specific inductive capacity of a solvent and the dissociation of the dissolved salt. But this is one of the questions not yet ripe for treatment in a discourse such as this.

I had also thought of saying something as to the atomic character of electricity, and the compounds of electricity with what we may venture to call the other chemical elements, and had even some idea of poaching on Lord Kelvin's domain of 'Aepinus atomized,' but time has saved me from this.

I have been describing the history of the theory of electrolysis from the time of Faraday, in such a way as is possible within the limits of an hour. I have necessarily omitted mention of many active, able and successful workers, and I cannot in every case justify the omission except by referring to the time limit. I have as far as I could explained the evidence which we have for the theories described, but I have not intended to argue for or against the essential truth of them. I have sometimes been asked in reference to the theory of electrolytic dissociation, Do you really believe it to be true? My answer to that question is, I believe it to be an eminently useful theory. It has led to a great deal of most valuable experimental work. It has enabled us to group together things that without its help seemed very little connected. It has led to the discussion of problems that could scarcely, without its suggestion, have occurred to any one. It does not seem to be exhausted, and I look forward to much good to be got from it yet, and therefore I am willing to take it as a guide. But I do not look on it as an infallible guide; we cannot expect, we do not need, an infallible guide in physical science. A long life may be anticipated for this theory; if that be so, we may be sure that it will undergo modifications, for if it is to act, it will be acted on.

Nothing but good can come from the fullest discussion, either of the theoretical basis or of the experimental evidence for or against a theory. No great principle in science or in law can be satisfactorily settled without full argument by competent advocates on both sides, and the eager hunt for evidence by those who attack and by those who defend will lead to a more complete investigation of the whole field than

would be attained without such—shall we call it partisan?—interest.

A. CRUM BROWN.

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*THE BOTANICAL SOCIETY OF WASHINGTON.*

BOTANICAL development at the national capital has been so rapid within the last few years that few outside of Washington comprehend that it has become the leading botanical center of America and is rapidly taking position as one of the leading botanical centers of the world. Probably no city in the world can boast of a larger number of well-trained professional men devoting their entire time to the study of botany in some one of its various branches. The aggregation of so large a number of professional botanists has finally led to the formation of a general botanical society which is of more than passing interest, as there is hardly a university of any note in the country that is not represented by graduates among its members.

The Biological Society of Washington was the first society organized in Washington which gave any attention to botanical matters. This society was too formal and did not allow of sufficient discussion to suit some of the botanists, and as a result in 1893 the 'Botanical Seminar' was organized, the original membership including Messrs. F. V. Coville, D. G. Fairchild, B. T. Galloway, Theo. Holm, E. F. Smith and M. B. Waite. The main aim of the Seminar was to discuss general problems of plant physiology and pathology and to promote a friendly spirit of criticism. In the early days of the Seminar no member published a paper until it had been read or summarized before the Society and had run the gauntlet of criticism which, the writer can testify, was frequently so severe as to be perilous to the peace of mind of the member under criticism. In no other society which the writer has ever attended was criticism so freely indulged in, or, it may be remarked, so pleasantly received. As it is axiomatic that no two minds ever think exactly alike, so it came to be an understood thing that no paper would suit everyone and many a lively discussion and tilt of warm words resulted.

The organization of the Seminar was somewhat novel, being mainly remarkable for its lack of organization. The Seminar had no officers and no constitution and its membership, though very exclusive, existed only as tradition or in memory. The meetings were held at the residences of members, the host of the preceding meeting acting as chairman. The membership was limited to twenty-five and unanimous consent of all members was required for election to membership.

In the nine years of its existence the Seminar filled an important place in Washington's botanical development, both scientifically and socially. A light lunch was served at each meeting and these light lunches, which sometimes became heavy, served as they were at 11 P.M., became famous among the members. It may be said that the fire of scientific enthusiasm requires no midnight lunch to feed upon, but it is certain that no matter how keenly the scientific fire burns a lunch during the evening adds to the flow of ideas and is conducive to 'that satisfied feeling' which makes all members regular attendants.

Within a few years the number of botanists in Washington became too large to be accommodated in the botanical seminar, meeting as it did in private houses, and in 1898 the Washington Botanical Club was organized particularly to consider the problems of systematic botany and furnish a means of communication between botanists interested in systematic and ecological studies. The organization of this club was largely brought about through the activity of Mr. C. L. Pollard and the late Gilbert H. Hicks. The general plan of this organ-

ization was similar to that of the seminar, but differed in having a corps of regular officers.

Dr. E. L. Greene was elected as the first president and Mr. C. L. Pollard as the first secretary, and they were retained in these offices until the society disbanded, when the Washington Botanical Society was organized.

The Botanical Seminar and Botanical Club worked harmoniously and well for a few years, but the rapidly increasing number of botanists in Washington rendered it desirable that a general society should be organized in which all of the botanists could be brought together at least occasionally. Private houses were in general found to be too small to accommodate comfortably even a membership of twenty-five, to which the seminar was limited, and numerous botanists of equal professional rank were asking for admission.

The organization of the Botanical Society of Washington was finally effected by a resolution of the constituent societies at a joint meeting held November 28, 1901. The course of events leading up to this action was as follows:

As a result of the general sentiment in favor of consolidation the Botanical Seminar appointed a committee consisting of Messrs. H. J. Webber, O. F. Cook and M. B. Waite, and the Botanical Club a committee consisting of Messrs. C. L. Pollard, David White and William R. Maxon, to consider plans of organization. As a result of the deliberation of the committee a plan of organization was devised and a joint meeting of the two societies was called at which the organization was perfected and the following constitution was adopted:

CONSTITUTION.

*Article* I.

The name of this Society shall be the Botanical Society of Washington.

*Article* II.

The object of this Society shall be the exposition and discussion of the results of botanical investigations, and the promotion of social intercourse among the members.

*Article* III.

The members of the Society shall be residents of Washington or vicinity having a professional interest in botanical science.

*Article* IV.

1. The officers of the Society shall consist of a President, a Vice-President, a Recording Secretary, a Corresponding Secretary and a Treasurer. These officers shall constitute the Executive Committee.

2. Officers shall be elected annually by ballot, and shall hold office until their successors are elected. The Executive Committee shall have power to fill vacancies until the next annual election.

*Article* V.

This Constitution may be amended at any regular meeting by a two thirds' vote of the total membership, written notice of the proposed amendment having been submitted at the preceding regular meeting. Absent members may register their votes by letter.

The first officers of the society, elected at the same meeting, were as follows: President, Albert F. Woods; Vice-President, F. V. Coville; Recording Secretary, C. L. Pollard; Corresponding Secretary, Herbert J. Webber; Treasurer, Walter H. Evans.

One novel feature of the society is that while the president presides at all business meetings and represents the Society officially as in ordinary societies, spice is given to the scientific programs by the by-law which provides that 'the scientific program of each regular meeting shall be conducted by a Chairman of Program; and that the same Chairman shall not preside over more than one meeting during the year.'

Meetings are held monthly and each meeting is preceded by an informal dinner at the regular dinner hour, 5:30 P.M. The following is a list of the present members of the Society:

LIST OF MEMBERS.

Carleton R. Ball, M.S. (Iowa Agricultural College). Assistant Agrostologist, Department of Agriculture.

William R. Beattie, B.S. (Ohio State University). Assistant in Testing Gardens, Department of Agriculture.

Ernst A. Bessey, M.A. (University of Nebraska). Assistant in Charge of Seed and Plant Introduction, Department of Agriculture.

Edgar Brown, Ph.B. (Union College). Assistant Botanist, Department of Agriculture.

Frank K. Cameron, A.B., Ph.D. (Johns Hopkins University). Soil Chemist, Department of Agriculture.

Mark A. Carleton, M.S. (Kansas Agricultural College). Cerealist, Department of Agriculture.

Joseph S. Chamberlain, M.S. (Iowa Agricultural College), Ph.D. (Johns Hopkins University). Expert in Physiological Chemistry, Department of Agriculture.

Victor K. Chesnut, B.S. (University of California). Botanist in Charge of Investigations of Poisonous Plants, Department of Agriculture.

Guy N. Collins, Assistant Botanist in Tropical Agriculture, Department of Agriculture.

O. F. Cook, Ph.B. (Syracuse University). Botanist in Charge of Tropical Agriculture, Department of Agriculture.

Lee C. Corbett, M.S. (Cornell University). Horticulturist of Bureau of Plant Industry, Department of Agriculture.

Frederick V. Coville, A.B. (Cornell University). Chief Botanist, Department of Agriculture.

Lester H. Dewey, B.S. (Michigan Agricultural College). Assistant Botanist in Charge of Investigations of Fiber Plants, Department of Agriculture.

Benjamin M. Duggar, A.M. (Harvard University), Ph.D. (Cornell University). Plant Physiologist, Department of Agriculture.

Arthur W. Edson, B.S. (University of Vermont). Scientific Aid in Plant Breeding Laboratory, Department of Agriculture.

Walter H. Evans, M.S., Ph.D. (Wabash College). Botanical Editor *Experiment Station Record*, Department of Agriculture.

David G. Fairchild, B.S. (Kansas Agricultural College). Agricultural Explorer, Department of Agriculture.

Beverly T. Galloway, B.S. (University of Missouri). Chief of the Bureau of Plant Industry, Department of Agriculture.

Harris P. Gould, B.S. (University of Maine), M.S. (Cornell University). Assistant Pomologist, Department of Agriculture.

Edward L. Greene, Ph.B. (Albion College), LL.D. (University of Notre Dame). Professor of Botany, Catholic University of America.

David Griffiths, M.S. (South Dakota Agricultural College), Ph.D. (Columbia University). Assistant Agrostologist in Charge of Range Investigations, Department of Agriculture.

Charles P. Hartley, M.S. (Kansas Agricultural College). Assistant in Plant Breeding Laboratory, Department of Agriculture.

Albert S. Hitchcock, M.A. (Iowa Agricultural College). Assistant Agrostologist in Charge of Cooperative Experiments, Department of Agriculture.

Fred. H. Hillman M.S. (Michigan Agricultural College). Assistant in Seed Herbarium, Botanical Investigations, Department of Agriculture.

Thomas H. Kearney, Assistant Physiologist in Plant Breeding Laboratory, Department of Agriculture.

Karl Kellerman, B.S. (Cornell University). Scientific Aid, Plant Physiological Laboratory, Department of Agriculture.

Frank H. Knowlton, M.S. (Middlebury College), Ph.D. (Columbian University). Paleontologist, Geological Survey.

William R. Maxon, Ph.B. (Syracuse University). Aid in Cryptogamic Botany, Division of Plants, National Museum.

R. E. B. McKenney, M.S. (University of Pennsylvania), Ph.D. (Basel University). Expert, Vegetable Physiological and Pathological Investigations, Department of Agriculture.

George T. Moore, M.A., Ph.D. (Harvard). Algologist and Plant Physiologist, Department of Agriculture.

Edward L. Morris, A.M. (Amherst College). Head of the Department of Biology, Washington High Schools.

Jesse B. Norton, M.S. (Kansas Agricultural College). Scientific Aid in Plant Breeding Laboratory, Department of Agriculture.

J. B. S. Norton, M.S. (Kansas Agricultural College). Professor of Botany and State Pathologist, Maryland Agricultural College and Experiment Station.

William A. Orton, M.S. (University of Vermont). Assistant Plant Pathologist, Department of Agriculture.

Adrian J. Pieters, B.S. (University of Michigan). Botanist in Charge of Seed Laboratory, Department of Agriculture.

Charles L. Pollard, A.B., A.M. (Columbia University). Assistant Curator, Division of Plants, National Museum.

G. Harold Powell, M.S. (Cornell University). Assistant Pomologist, Department of Agriculture.

Percy L. Ricker, M.S. (University of Maine). Scientific Aid in Agrostology, Department of Agriculture.

J. N. Rose, M.A., Ph.D. (Wabash College). Assistant Curator, Division of Plants, National Museum.

Filibert Roth, B.S. (University of Michigan). Chief of Forestry Division, in Charge of U. S. Forestry Reserves, Department of Interior.

Carl S. Scofield, B.S. (University of Minnesota). Expert on Cereals, Department of Agriculture.

Cornelius L. Shear, A.M. (University of Nebraska). Assistant Plant Pathologist, Department of Agriculture.

Erwin F. Smith, B.S., D.Sc. (University of Michigan). Pathologist in Charge of Laboratory of Plant Pathology, Department of Agriculture.

William J. Spillman, M.S. (University of Missouri). Chief Agrostologist, Department of Agriculture.

Dean B. Swingle, B.S. (Kansas Agricultural College), M.S. (University of Wisconsin). Scientific Aid in Laboratory of Plant Pathology, Department of Agriculture.

Walter T. Swingle, M.S. (Kansas Agricultural College). Physiologist in Charge of the Laboratory of Plant Physiology, Department of Agriculture.

William A. Taylor, B.S. (Michigan Agricultural College). Pomologist in Charge of Field Investigations, Department of Agriculture.

Charles O. Townsend, M.S. (University of Michigan), Ph.D. (Leipzig). Plant Pathologist, Department of Agriculture.

J. E. W. Tracy, B.S. (Michigan Agricultural College). Expert Seed Tester, Department of Agriculture.

Rodney H. True, M.S. (University of Wisconsin), Ph.D. (Leipzig). Plant Physiologist, Department of Agriculture.

Merton B. Waite, B.S. (University of Illinois). Pathologist in Charge of Investigations of Diseases of Orchard Fruits, Department of Agriculture.

Herbert J. Webber, M.A. (University of Nebraska), Ph.D. (Washington University). Plant Physiologist in Charge of Laboratory of Plant Breeding, Department of Agriculture.

David White, B.S. (Cornell University). Geologist, Geological Survey.

Milton Whitney, Chief of the Bureau of Soils, Department of Agriculture.

William F. Wight, B.S. (Michigan Agricultural College), M.A. (Stanford University). Assistant, Geographic Botany, Department of Agriculture.

Earley V. Wilcox, Ph.D. (Harvard University). Associate Editor of *Experiment Station Record*, Department of Agriculture.

Albert F. Woods, M.A. (University of Nebraska). Chief Pathologist and Physiologist, Department of Agriculture.

Total membership, 57.

The plan of organization of the Society provides that, whenever it seems desirable, seminars may be formed for the study and discussion of special topics. Such seminars are to be associated with the Society and to be conducted mainly on the plan of the original Botanical Seminar. Four such seminars have already been formed, namely: (1) Agronomic Seminar, (2) Physiological and Pathological Seminar, (3) Plant Breeding Seminar, (4) Systematic Botanical Seminar.

Botanical activity in Washington is rapidly increasing and the present list of members will probably be greatly enlarged within the next year.

It is not probable that the Society will publish proceedings or issue any papers in the near future; but hereafter reports of the meetings will be furnished to SCIENCE whenever the program is of such a nature as to justify a report.

HERBERT J. WEBBER,
*Corresponding Secretary.*

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### *THE MOSQUITO CAMPAIGN IN NEW JERSEY.*

THERE has been much comment in the Press on the above matter since Assembly bill No. 31 was first introduced in the New Jersey Legislature. Though the bill is

very short, few journals printed it, and when printed it appears that very few read it carefully enough to understand its real purport. The common belief seems to be that for the sum of $10,000 the State Entomologist is to destroy all the mosquitoes in the state during the current season. It needs only the most casual acquaintance with the character of the problem to make it obvious that any attempt to such an end would be foredoomed to ridiculous failure; but it was just this misapprehension that is accountable for such opposition as the real scheme met with. The act is so short and its objects are so briefly set out that it is here presented in full.

AN ACT TO PROVIDE FOR AN INVESTIGATION AND REPORT BY THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION, UPON THE MOSQUITO PROBLEM, IN ITS RELATION TO THE SANITARY, AGRICULTURAL AND OTHER INTERESTS OF THE STATE.

*Be it enacted by the Senate and General Assembly of the State of New Jersey:*

1. That the New Jersey Agricultural Experiment Station be and the same is hereby empowered and directed to investigate and report upon the mosquitoes occurring within the State, their habits, life history, breeding places, relation to malarial and other diseases, the injury caused by them to the agricultural, sanitary and other interests of the State, their natural enemies, and the best methods of lessening, controlling or otherwise diminishing the numbers, injury or detrimental effect upon the agricultural, sanitary and other interests of the State.

2. The sum of ten thousand dollars is hereby appropriated to the New Jersey Agricultural Experiment Station to be applied to and expended for the purposes mentioned in section one of this Act. Such expenditures to be made and accounted for in the same manner as are the other moneys appropriated to said Station.

3. This Act shall take effect immediately.

This act passed the House with little opposition and by a good majority; but in the Senate it encountered active hostility. That body could not be persuaded that there was a serious purpose behind the bill. Nevertheless it was favorably reported from the committee to which it had been referred, only to find a place in the presiding officer's 'forgotten corner,' whence, it was intended, it should never be removed. But even Senators change sometimes and, for some reason, the bill was resurrected, brought up for final reading and lost by a tie, changed to a negative vote by one of the advocates of the measure who voted nay that he might move for a reconsideration. The motion to reconsider was made and tabled, leaving a chance for life which was seized in the closing hours of the session.

Public opinion expressed by the newspapers had been and continued to be almost uniformly favorable to the measure and this induced some of the opposition to change their previous negative to affirmative votes.

Nominally therefore the Legislature of the State of New Jersey had passed a bill appropriating $10,000 for an investigation and report on the mosquito question and this act was approved by the Governor in due time.

A general State law requires that all sums of money to be paid out by the Comptroller must be included in one of the regular appropriation bills. The regular appropriation bills, however, have been completed and were upon final passage when the mosquito bill passed. No mention of any sum of money for this purpose appears in either the supplementary or the regular appropriation bill passed by the Legislature, consequently there was no money available for the purposes of the act, which, so far as the law-making body is concerned, would have to remain inoperative until a future session should see fit to provide the necessary funds.

The matter was presented to the Governor of the State and he was asked to con-

sider a request to devote a small sum from an emergency fund, which is under his personal control, that an organization for work might be effected. The Governor had already expressed a favorable interest in the subject and after consideration agreed to assign the sum of one thousand dollars to the purposes mentioned in the bill. It is quite obvious that this sum is totally inadequate to the carrying out of the plan originally formulated, which involved the expenditure of ten times the amount in hand; but considerable preliminary work may be done that will simplify matters when the full sum becomes finally available.

One part of the fund will be devoted to an investigation of the conditions which favor the transmission of malaria in certain districts in the State, and a competent man has been secured for that purpose. He will be located in a malarial district where *Anopheles* is abundant and its breeding places numerous. This will afford opportunity for a careful study of the condition under which these mosquitoes are able to carry the organisms causing the disease. The student will be supplied with material from other districts in the State where malaria as an endemic disease is practically unknown. This material will be used in comparison with that collected in the infected locality, and if possible a comparative study of the media in which the larvæ breed will be made.

Another subject that will be taken up by one thoroughly qualified for the work is a study of the food habits of such vertebrates as live in the waters inhabited by mosquito larvæ. It is further expected that collections will be arranged for throughout the State that the mosquito fauna may be thoroughly understood, and the various species locally involved may be intelligently considered.

The general survey of the salt-marsh region, which was contemplated as part of the original plan, will have to be postponed for the present. It will be possible, however, for me to cover the ground in a preliminary way, that I may be fully informed when I am able to put field parties into active service.

Aside from the general work here outlined some of the more common species will be bred in the laboratory in quantities sufficient to allow of experiments with poisonous materials. The application of oil on a large scale has been found somewhat unsatisfactory, and while there is no doubt of its effectiveness in general, there are occasions when its use should be avoided if possible.

This outline of what has been done and what it is expected to do is presented that the scientific world at least should be under no misapprehensions in this matter.

JOHN B. SMITH.

NEW BRUNSWICK,
May 15, 1902.

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## SCIENTIFIC BOOKS.

*A University Text-book of Botany.* By DOUGLAS HOUGHTON CAMPBELL, Ph.D., Professor of Botany in the Leland Stanford Junior University. New York, The Macmillan Company; London, Macmillan & Co., Ltd. 1902. All rights reserved. 8vo. Pp. xv+579. With many illustrations.

It has been the pleasant task of the present reviewer on several previous occasions to notice books prepared by Dr. Campbell, each time with increased interest. There was first a little text-book for High Schools—the 'Elements of Structural and Systematic Botany'—which appeared twelve years ago, and justified the reviewer's favorable estimate. Five years later came that admirable book—the 'Structure and Development of Mosses and Ferns'—which has been a handbook of advanced botanists since its publication. This was followed in 1899 by 'Lectures on the Evo-

lution of Plants,' one of the most suggestive and readable of recent books on the philosophical aspects of botanical science. We may see the steps in the evolution of a leading botanist in the preceding books, especially when we add to the list the one which has just appeared, and which is here to be noticed.

The author brings to the task of preparing a book for university students long experience in teaching in the high school, as well as the university, and his many explorations in new fields of botanical research add greatly to his preparation. One might say that his earlier works have been preparatory to this, and that in their preparation he was laying the foundations upon which to build this compendium of the science. He has made this a book of reference, and it is very distinctly stated that it is not a laboratory manual. We have here an indication of a recession of the tide which at one time seemed likely to sweep away everything that was not of and for the laboratory or the field. The book is thus a contribution to the discussion of the methods of teaching botany, and as such we welcome it as an omen of better things than we have had. It is an 'all-round' book, and the student who is so fortunate as to be led through it by a competent teacher will not come out of the university with one-sided notions of the subject. It should represent the 'general botany' course in the university, as distinguished from the botanical work in the college. Upon what is contained in it the student who intends to become a professional botanist or who wishes to take up particular lines of work in restricted fields may build with safety.

The book is made up of fifteen chapters, as follows: I., 'Introduction' (in which certain generalities are discussed); II., 'The Plant-body' (which is general morphology); III., 'The Plant-cell'(cytology and histology); IV., 'Classification' (really devoted to the Flagellata, Myxomycetes, Schizomycetes, Schizophyceæ and Diatoms); V., 'The Algæ'; VI., 'Fungi'; VII., 'The Archegoniatæ (Bryophyta)'; VIII. and IX., 'Pteridophyta'; X., 'Spermatophyta (Gymnosperms)'; XI., 'Angiospermæ (Monocotyledones)'; XII., 'Dicotyledones'; XIII., 'Physiology'; XIV., 'Relation to Environment'; XV., 'Geological and Geographical Distribution.' There is thus a fair balance in the treatment of the different parts of the subject.

In looking over these chapters we are particularly pleased with those on the 'Plant-cell' (III.), the 'Bryophyta' (VII.), and the 'Pteridophyta' (VIII. and IX.). Here the author is quite at home, and the treatment is with a firmer hand than elsewhere. These chapters afford him the opportunity of applying his intimate knowledge of these groups in the presentation of the matter in pedagogical as well as scientific form. It is needless to say that the whole presentation is from the standpoint of modern evolution, and at every step the student is led to see that all forms are derived from similar antecedent forms. Yet the author is cautious, and does not assume to know all of the details of the evolution of present vegetation. It is a sound, scientific book, a credit to American botanical science.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

*Text-book of Zoology Treated from a Biological Standpoint.* By Dr. OTTO SCHMEIL. Translated from the German by RUDOLPH ROSENSTOCK. Edited by J. T. CUNNINGHAM. London, A. and C. Black. 1901. Pp. xvi+493.

The first impression that this book is apt to make upon the morphologically trained zoologist is that it is somewhat crude and often deals with merely trivial matters. A more careful study of the book shows that the first impression is an inadequate one. Here we have a philosophical treatise of zoology: one of the first. Thus even the morphological reader will admit now that it is becoming clear that morphology demands a physiological interpretation. And that is what the author of this book attempts to give us. As an example of the method let us take the treatment of the European wild boar (*Sus scrofa*). First, a brief statement as to dimensions and weight (how important for structure!). Next, "The wild boar prefers for its habitat swampy forest thickets, which are avoided by all other

native mammals. Hence it is hardly surprising that in the structure of its body this animal exhibits marked differences from all the other habitants of the forest." Like the elephant, it forces its way through the thickets. It is consequently equipped with (1) a conical head; (2) short, powerful legs; (3) tough skin; (4) coat of bristles; (5) deep-set eyes. It lives in the marsh. The separating toes prevent sinking; the body is kept from cooling in the water by the thick layer of fat. The bristles dry quickly so that little heat is lost. The boar is omnivorous, hence such and such teeth, hearing, sight. It burrows, hence shape of head, snout, canine teeth, muscles of neck, spinous processes of cervical vertebræ, distribution. Finally the boar has certain relations to man.

This method is followed throughout the book. It is very illuminating. The great difficulty is that in the attempt to explain everything one cannot but feel that the author sometimes resorts to explanations that are merely possible and plausible.

On the whole, however, the book is to be strongly commended to the general reader and to the consideration of the teacher of zoology in secondary schools and colleges. This is the sort of zoology that is to be preferred to pure morphology as an introduction to the science. The selection of such heavy paper and large size of pages seems unfortunate for a text-book, for, because adding to the price of the book, they must restrict its use.

C. B. Davenport.

*Handbook on Sanitation.* A Manual of Theoretical and Practical Sanitation. By George M. Price, M.D. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1901. 12mo. Pp. xii+317; figs. 31. Cloth, $1.50 *net.*

The book is of four parts, 'Sanitary Science,' 'Sanitary Practice,' 'Sanitary Inspection' and 'Sanitary Law.'

Part one is stated to be a 'condensed but comprehensive résumé of the best text-books.' It is vastly too condensed to be of use to 'students and physicians.' Thus the question of 'water and water-supply' is disposed of in seven and a half pages, and nine and a half are given to 'sewage and sewage disposal.'

Carbon dioxide should not be classed as a 'virulent poison,' and the statement that carbon monoxide 'may produce death when inhaled in large amounts' does not do justice to the highly poisonous qualities of that gas.

On page 21 it is written that 'as a rule the height of a room ought to be about one third of the cubic space.'

The error of such an expression is apparent. Possibly the author had in mind the 'cube root' rather than 'one third.'

The chapters on plumbing are good and well illustrated.

Considerable information of value, such as tables of measurements, elementary mensuration, extracts from civil service rules, and tenement-house law, is included in the last half of the volume. As a whole, the book contains material useful to a certain class of inspectors, but it is an error to entitle it 'a manual of theoretical and practical sanitation.'

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## *SCIENTIFIC JOURNALS AND ARTICLES.*

*The Botanical Gazette* for May contains the following articles: The third and last part of the paper by Frederick C. Newcombe on 'The Rheotropism of Roots' appears, and the paper as a whole embodies important results from several years of experimentation. Mr. Newcombe's first paper upon the subject was read before the American Association in 1896. The detailed results of the numerous well-devised experiments cannot be given, but the conclusion of the whole matter may be summed up as follows: Rheotropism is an obscure phenomenon manifested in the curving of roots against a stream of water. The author finds the response not general among plants, there being but twenty sensitive species out of thirty-four tested. Velocities of flow causing a response may range from 0.1 cm. to 500 cm. per minute, though the strongest curves are formed in velocities between 100 cm. and 500 cm. per minute. A remarkable discovery was made in finding the roots sensitive not only at the apex and throughout the elongating zone, but for some distance

beyond the elongating zone. Rheotropism is not a transitory phenomenon, but persists in the maturing plant. It is perhaps a response to pressure, though terrestrial roots are not known to be sensitive to pressure. Kiichi Miyake writes 'On the Starch in Evergreen Leaves and its Relation to Photosynthesis during the Winter.' The work was carried on at the Tokyo Imperial University and the conclusions reached have to do with conditions in Japan. The starch in evergreen leaves in general begins to decrease in November, reaching its minimum during January, and increasing again from the end of February. During the winter many evergreen leaves contain starch, and this starch, as experiments showed, is formed by photosynthesis in winter and its translocation occurs in the same season. This phenomenon is true of middle and southern Japan, but in northern Japan most evergreen leaves lose their starch in winter. The opening of the stomata in winter was also observed in some evergreen leaves in Tokyo. James B. Overton describes 'Parthenogenesis in *Thalictrum purpurascens*.' Embryos were produced parthenogenetically under all artifical conditions, and wild material showed the phenomenon to be general in nature. The cytoplasm of the early stages of the sac is closely packed about the egg, which later becomes surrounded by a modified zone which may affect the osmotic pressure and indicate a withdrawal of water, causing the egg to divide. No differences could be detected in the development and vigor of normal and parthenogenetic embryos, except that the latter is slower in starting. *Thalictrum* is the third genus of angiosperms in which parthenogenesis has been recorded, the others being *Antennaria*, described by Juel, and *Alchemilla*, described by Murbeck. R. G. Leavitt describes some subterranean plants of *Epiphegus*, which were dwarf specimens, buried one or two inches deep, but with flowers and fruit in all stages of development. D. G. Fairchild, in continuing his 'Notes of Travel,' describes the bright-colored autumn foliage of American trees in Europe, special mention being made of *Quercus rubra* and *Acer dasycarpum*. T. D. A. Cockerell describes a new *Heliotropium* from New Mexico.

THE May number of *Popular Astronomy* has two brief articles by J. E. Gore, of England; the one on 'Immensity and Minuteness' brings out the vastness of the numbers dealt with in astronomy, and contrasts them with the minuteness of atoms as revealed by the microscope. He cites as illustrations that the distance of the nearest fixed star is 271,000 times the distance of the sun, and the fact that certain forms of infusoria are so minute that an individual specimen can lie between two divisions of an inch divided into 25,000 parts. Mr. Gore's second article gives his new method of computing the value of starlight in terms of moonlight. William L. Hornsby, for some years a resident of China, writes from Macao of 'The Chinese Calendar.' He finds that calendars in China date back to their earliest classic records, and traces the history of their calendars to modern times including extracts from those of the present day, which show a curious mixture of astrology, superstition and astronomy. Other popular articles are 'Shadows Cast by Starlight,' by Henry Morris Russell, and an account of the appearance of the 'The Stellar Floor' as seen through the clear steady atmosphere at Mt. Lorne Observatory, by Edgar L. Larkin; also a review of the Solar Observations of 1900, and a brief account by Dr. T. D. Anderson, the discoverer of Nova Persei, of his 'Searching for New Stars.'

## *SOCIETIES AND ACADEMIES.*

### SIXTH REGULAR MEETING OF THE BOTANICAL SOCIETY OF WASHINGTON.

THE sixth regular meeting of the Botanical Society of Washington was held at the Portner Hotel, March 29, 1902, with President A. F. Woods in the chair. At the conclusion of the business meeting, Mr. A. J. Pieters, chairman of the program for the evening, was called on to preside.

Professor A. S. Hitchcock discussed a peculiar specimen of short-leaf pine which he had observed. The tree had been girdled and had continued growing above the wound, so that

while the circumference below the girdled area was about 24¼ inches, the tree above had expanded to a circumference of about 47 inches. The discussion developed the fact that this occurrence is not unusual in some kinds of trees when they have been girdled.

The main portion of the evening was devoted to a symposium on Cuban vegetation.

Mr. C. L. Pollard briefly suggested the ecological areas as he recognized them, illustrating his remarks by mounted specimens.

Mr. William Palmer, of the U. S. National Museum, gave an exhaustive account of the geological formations of the island and their effect on vegetation. Mr. Palmer also discussed at some length the influence annual fires have had on the vegetation.

By invitation, Dr. C. F. Millspaugh, of the Field Columbian Museum, gave a short address on West Indian vegetation in general, pointing out the life zones and commenting on the zones of vegetation. A brief discussion followed on the character of the peculiar red soils common in most parts of Cuba. Mr. Woods pointed out that these soils are also common in Bermuda and that it is probable that in many cases such soils are subject to change of color after long cropping.

Herbert J. Webber,
*Corresponding Secretary.*

SEVENTH REGULAR MEETING OF THE BOTANICAL SOCIETY OF WASHINGTON.

The seventh regular meeting of the Botanical Society of Washington was held at the Portner Hotel, April 26, 1902, with President A. F. Woods in the chair.

Mr. L. C. Corbett called attention to the use of ether in forcing dormant plants into flower. Experiments which have been conducted indicate that treatment with fumes of ether in tight receptacles covering the tops will succeed in bringing dormant plants into bloom in from twelve to fourteen days. Experiments thus far conducted have been mainly with the lilac.

Mr. A. F. Woods called attention to the fact that the treatment of seeds with ether hastens germination, and spoke briefly of experiments conducted by himself which demonstrated this fact.

Mr. V. K. Chesnut reviewed a paper by Dr. Maurice Henseval entitled 'L'Abrine du Jéquirity,' published in *La Cellule,* Vol. 17, pp. 139–197, 1900. In this paper the author describes numerous accurately performed experiments upon the smaller animals with sterilized solutions containing a definite quantity of the toxalbumin *abrin,* extracted from the seeds of *Abrus precatorius,* showing in considerable detail its chemical, physical and physiological characteristics, especially in their relation to the destruction of abrin in the intestines and by leucocytes.

Dr. C. O. Townsend discussed a report by Professor Jones, of the Vermont Experiment Station, on the 'Use of Bodo and Pyrox,' two fungicides prepared by the Bowker Chemical Company. Bodo, it was stated, compares in general with Bordeaux mixture, while pyrox compares with a mixture of Bordeaux and Paris green, and is used as a fungicide and insecticide. In Professor Jones' experiments it was found that these preparations gave very satisfactory results. Dr. Townsend also mentioned experiments made by himself with bodo in which very satisfactory results were obtained. The conclusion seemed to be that while bodo may not be as effective as freshly prepared Bordeaux mixture, when properly made, it is probably better than improperly prepared Bordeaux.

Mr. M. A. Carleton called attention to two general laws regarding seed of wheats which have come to be generally understood. (1) That in case of spring wheats seed brought from the north ordinarily ripens earlier and gives better yields and quality than seed of the same variety brought from the South. (2) That in the case of winter wheats just the opposite is true, that is, that seed from the South gives the best results. This was stated as being a general law for winter crops. As a rule seed from the South in the case of winter crops ripens earlier and yields better than seed from the North. Mr. C. R. Ball called attention to the fact that varieties of cow-peas which in

the South produce running vines when transplanted to the North change to a bushy habit.

Mr. C. P. Hartley outlined some results obtained in growing corn from red-eared sports. In one case a pure red ear was found in a field of a white race which had been bred true to type for a number of years. Seed from this red ear was planted, and in the first generation about 45 per cent. of the progeny had red ears while the remaining 55 per cent. gave white ears. Some of the red ears were self-fertilized, and in the second generation grown from such self-fertilized seed 83 per cent. of red ears were produced. Another sport was described where in a race of pure bred white corn an ear was produced which was mainly red, but had a white spot at the base on which the kernels were white with very fine red stripes. The red grains from this ear when planted produced progeny in which 50 per cent. of the ears were red, while the kernels from the white spot gave progeny in which 50 per cent. of the ears had seed like that planted, with fine red stripes, and 50 per cent. had pure white ears.

Mr. H. J. Webber exhibited a plant of trailing arbutus (*Epigæa repens*), received from South Carolina, which produced double flowers. The doubling was caused by the stamens developing into petals, the expanded filaments being united into a tube similar to the corolla in which it was inserted. Mr. Webber also called attention to an experiment with cotton, showing the prepotency of pollen of different species. In the summer of 1900 flowers of Sea Island cotton were opened about 7 A.M. and abundantly pollenated with their own pollen, after which they were bagged. These same flowers were opened again about 11 A.M.—four hours later—and dusted abundantly with pollen of upland cotton. The seeds produced by such cross-pollenated flowers were planted the next year and gave over 50 per cent. of true hybrids, showing that pollen of upland cotton on Sea Island is sufficiently prepotent over the plant's own pollen to give a large percentage of hybrids even when applied four hours later. It was pointed out that results similar to these were obtained by Darwin in experiments with different varieties of cabbage.

HERBERT J. WEBBER,
*Corresponding Secretary.*

## GEOLOGICAL SOCIETY OF WASHINGTON.

AT the 131st meeting, held May 14, 1902, the following papers were presented by members of the Maryland Geological Survey: 'The Potomac Group in Maryland,' by W. B. Clark and A. Bibbins.

The Potomac group is composed of four distinct formations called from below upward the Patuxent, the Arundel, the Patapsco and the Raritan formations. These are separated by clearly defined unconformities. The two lower formations are provisionally assigned to the Jurassic because of the discovery by Professor Marsh of dinosaurian remains within the Arundel formation, the dicotyledonous plant remains being mainly confined to the Patapsco and Raritan formations. Only a few dicotyledons are known from the lower formations. By the gradual transgression of the formations northward the Raritan ultimately rests upon the Piedmont Plateau of New Jersey, while southward the transgression of the Tertiary gradually buries the higher formations, the Raritan disappearing near the latitude of Washington.

The character of the Potomac basin of deposition is shown by well borings which indicate a distinct rise in the level of the Potomac surface in the Delaware peninsula.

'The Correlation of the Coal Measures in Maryland,' by W. B. Clark and G. C. Martin.

The Maryland Coal Measures have hitherto been largely studied independently of the same deposits in adjacent regions in Pennsylvania and in West Virginia, and as a result an independent classification has gradually been developed. The authors find, however, that not only the stratigraphic sequence but the fossiliferous horizons are identical with those in the adjacent regions of Pennsylvania and West Virginia, and they consider that the same classification should obtain. In the case of the lower members of the Coal Meas-

ures continuity of strata can be established, while even in the independent synclinal trough of the Georges Creek basin there is found the same sequence of strata and fossils. Numerous detailed measured sections were described in substantiation of these conclusions.

'A Reconnaissance of Mt. Hood and Mt. Adams,' by H. F. Reid.

These mountains belong to the group of volcanic cones built up mainly in Tertiary times along the line of the Cascade Range. Though probably extinct, steam and gases still issue in small quantities from cracks near the summits. The mountains consist of massive lava and lapilli, the latter being more abundant on Mt. Hood and the former on Mt. Adams. Some of the later lava-flows are probably not more than a few hundred years old. A number of parasitic cones are found on the flanks of Mt. Adams, two, at least, with well-marked craters, while none occur on Mt. Hood. About one half of the original crater wall of Hood still remains, the southern half having disappeared. The summit of Adams is long and broad. The stratification seen in the cliffs on the sides of the mountain suggest that there were several craters which may have been active at the same time or successively.

Many interesting glaciers lie on the slopes of both mountains; but they do not descend into the valleys. In several cases the depressions outside the lateral moraines are apparently quite as deep as the bed of the glaciers, and the cañons formed below the ends of the ice are deeply eroded, in strong contrast to ice-covered parts of the mountains. The main erosion has been effected by water, and the ice and snow, by preventing the concentration of the water, have protected the underlying rock.

There is little indication of a much greater extension of the glaciers of Hood in former times, but on Adams glacial scratches abound in positions not now reached by the ice.

'Recent Work in the Piedmont Area of Northern Maryland,' by Edward B. Mathews.

Areal mapping of the Piedmont Plateau in northeastern Maryland has been carried on during the last three years by the speaker, Miss F. Bascom and Mr. A. Johannsen. The formations present an intricate intermingling of igneous and metamorphic rocks comprising monzonites, gabbros, metarhyolites, and serpentines among the igneous rocks; and gneisses, quartz-schists, phyllites and slates among the metamorphosed sedimentary rocks.

The sequence of eruptions in the region is believed to include two periods, representing differentiated portions of an original magma of medium acidity. One formed the monzonites and was itself somewhat differentiated during the period of consolidation, monzonite; the second formed the gabbros, with the accompanying quartz-gabbros, norites and peridotites produced by secondary differentiation.

All of these have been intruded into the mica-gneiss which is either of early Paleozoic or pre-Cambrian age.

'The Miocene Formation of Maryland,' by G. B. Shattuck.

In the differentiation of the Chesapeake group, three well-defined formations are recognized, which are described from below upward under the names of Calvert, Choptank, and St. Mary's formations. An unconformity occurs between the Calvert and the Choptank. Well defined lithologic features mark the several formations, which have been mapped in great detail throughout southern and eastern Maryland. Each formation has its clearly defined fauna.

'The Pleistocene Problem in Maryland,' by G. B. Shattuck.

The gravel deposits of the North Atlantic Coastal Plain are divisible into five formations, which are known, beginning with the oldest, as the Lafayette, Sunderland, Wicomico, Talbot and Recent. The Lafayette has been doubtfully referred to the Pliocene; the Sunderland, Wicomico and Talbot are believed to be Pleistocene.

Each of these formations is developed in a distinct terrace which is separated from the adjacent terraces both above and below by well-defined scarps. These terraces lie one above the other, the oldest occupying the top of the series, and the youngest the bottom.

The agencies which have been instrumental

in cutting the scarps and depositing the materials of the various formations are marine, estuarian, fluviatile and possibly subaerial.

The North Atlantic Coastal Plain underwent numerous changes in altitude while the various formations were building. They are briefly as follows:

1. Subsidence and deposition of the Lafayette.
2. Elevation and erosion of the Lafayette.
3. Subsidence and deposition of the Sunderland.
4. Elevation and erosion of the Sunderland.
5. Subsidence and deposition of the Wicomico.
6. Elevation and erosion of the Wicomico.
7. Subsidence and deposition of the Talbot.
8. Elevation and erosion of the Talbot.
9. Subsidence and deposition of the Recent.

The subsidence appears to be still in progress.

F. L. RANSOME,
*Secretary.*

BIOLOGICAL SOCIETY AT WASHINGTON.

THE 365th regular meeting was held on Saturday evening, May 17.

Arthur H. Howell spoke on 'The Summer Birds of Mt. Mansfield, Vermont,' describing the fauna and flora of the region at some length, and stating that the flora in particular was characterized by the presence of a number of plants customarily found farther north. The paper was illustrated with lantern slides showing characteristic features of the region as well as some of the birds.

W. W. Cooke discussed 'Bird Migration Routes,' paying special attention to the theory that in crossing considerable bodies of water birds either followed along existing islands, or where islands or direct land connection had formerly existed. The speaker gave the results of long and careful observation of many migratory North American birds, and showed that in passing from our southern States to Yucatan and Central America, or in returning, the small birds passed directly over the Gulf of Mexico where there had never been land. Very few of our birds either wintered in Cuba or passed through it while migrating, while the popular idea that birds passed from North to South America along the Windward and Leeward Islands was entirely incorrect. Neither, as far as could be ascertained, did birds follow certain routes, or 'lanes,' in their migrations, but covered a wide area. V. K. Chesnut exhibited a number of slides showing various poisonous plants of the west, giving their Indian names and uses. F. A. Lucas showed slides of the large Claosaurus skeleton at Yale, stating that it was the first complete Dinosaur skeleton mounted in this country.

F. A. LUCAS.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY OF THE NEW YORK ACADEMY OF SCIENCES.

AT a meeting on April 28 a paper entitled 'Two Experiments in Color Vision' was presented by Professor Robert MacDougall, and in his absence was read by title. He has found (1) that the subjective intensity and saturation of a given constant objective color increases with the retinal area illuminated by it. This increase is most marked in case of green, least marked in case of red. A similar phenomenon appears in the grays. The apparent difference in brightness between a patch of gray and a light or a dark background is increased by enlarging the patch. (2) A given area of illumination produces a stronger subjective effect when this area is divided and distributed over the retina than when it is compact. This is perhaps because the area of irradiation is increased by distributing the area of illumination.

Professor J. E. Lough reported some experiments on the memory of school children. He had tested 682 schoolgirls ranging in age from 9 to 15. The method employed was the same as that used by Lobsien in a similar investigation of the school children of Kiel. A list of ten words was read to the pupils who then wrote down as much of the list as they could remember. This was repeated with new classes of words until eight lists had been given. These experiments show: (1) That memory improves but slightly between the ages 9 and 15, being 62 per cent. at 9 and 64 per cent. at 13 and 15. This is in sharp contrast with the results obtained by Lobsien—38 per cent. at 9 and 75 per cent. at 13. (2) That the amount remembered depends upon

the class of words composing the list—names of colors having an average of 87 per cent., names of concrete things 75 per cent., words connected with tactile experiences 70 per cent., emotions 68 per cent., sounds 58 per cent., abstract words 50 per cent., numbers 45 per cent. (3) That the usual retardation at 12 with acceleration at 13 is shown in each class of words, with the exception of emotions, where there is a marked retardation at 13, with acceleration at 14. (4) That in each of the lower grades of school (4A–5B) the brighter pupils have the better memory, while in each of the higher grades (6A–7B) the duller pupils have the better memory.

In discussing this paper, it was remarked by Professor Thorndike that grammar school girls of 14 to 15 do not fairly represent all girls of that age, since the brighter individuals are apt to leave the grammar school before reaching 14 years.

Professor Cattell, in a paper on the 'Intensity of Light and the Error of Perception,' described experiments in which 211 shades of gray between white and black were sorted out into the order of brightness. The steps were smaller than can be perceived, and there was consequently an error of displacement, measuring the just observable difference. For the more accurate observers the error was six cards or about 0.03 of the range between white and black. Observers differ within the extremes of about 1:2. The just observable difference increases with the magnitude of the stimulus, but not in direct proportion as required by Weber's law. The increase is more nearly in proportion to the square root of the magnitude, which the speaker has found to hold in other cases and has elsewhere attempted to explain.

Professor E. L. Thorndike presented results bearing on the question of 'Sex Differences with Respect to Variability.' A large number of psychological tests of school children has afforded him the opportunity of comparing the variability of boys and girls, as classes, and, on the whole, there is practically no difference between them.

Dr. W. Borgoras reported some results of his recent observations, undertaken for the Jesup North Pacific Expedition, in northeastern Siberia, among the Chuckchi, Koryak and Kamchadal peoples. These he found to resemble each other strongly in the structure of their languages and in their folklore. What is especially interesting is the striking similarity, almost identity, between some of their traditions and some of those current among the North American Eskimos and the Indians of British Columbia. It is not, however, the Asiatics living nearest to Bering Strait, but more southerly tribes, that show most evidence of kinship with the Indians.

R. S. Woodworth,
*Secretary.*

### Torrey Botanical Club.

At the meeting of April 30, held at the Botanical Garden, the first paper was by Dr. C. C. Curtis, on 'Some Features connected with Transpiration.'

Transpiration may be illustrated by a fluctuating curve. The maximum of the curve is found in the forenoon and corresponds to the periodicity in the stems. Transpiration can hardly be considered to be wholly a physical property. The volume of water given off by plants in the night is very considerable, and probably the stomata are never completely closed. It seems perfectly rational that the stomata are open, partly, in the dark, and that some transpiration takes place. During the early morning hours, the amount of water given off is much more than in the afternoon, as the stoma has become used to the light.

Another paper was by Professor F. E. Lloyd, on 'Compound Leaf Forms.' In many cases, when a leaf is lobed, or has one lobe, the leaf on the opposite side of the stem also has a lobe on the opposite side of the midrib. This may be seen in the bud as well as in full grown leaves; as in the pear, elm, etc.

The fourth paper was by Dr. H. M. Richards, on 'Turgor Changes in Injured Tissues.' It has been shown that the curved respiration in injured plant-tissues rises for a time and then falls off to the normal. The 'wound-fever,' or 'rise-in-temperature' curve is similar to that of respiration. Turgor changes apparently accompany these reactions towards

injury. The onion was used for experiment, and the wounded and uninjured bulbs were placed in a saturated atmosphere. The normal turgor pressure in terms of $KNO_3$ solution is about 3.5 to 4 per cent.; after wounding this falls about 0.5 per cent. As the heating goes on, four or five days after the wounding, the turgor has increased again, and the wounded and unwounded onions are practically the same in this respect. Carrot, beet and radish were also used.

Dr. MacDougall exhibited plants of *Monotropsis odorata* sent by Professor Johnson, of Johns Hopkins. He also showed a basket made by the Pima Indians of Mexico, made of *Typha, Martynia* and *Salix*. He also exhibited the ayal or calabash fruit from Sonora, of the genus *Crescentia,* a fruit of economic importance.

Miss Angell, of Plainfield, New Jersey, exhibited living plants of *Viola Angellæ* in flower. When the plant is flowering the scapes exceed the leaves; but later in the season the leaves overtop the scapes.

S. H. BURNHAM,
*Secretary pro tem.*

### UNIVERSITY OF WISCONSIN SCIENCE CLUB.

AT the monthly meeting of the club, held May 6, three papers were presented.

Professor Wm. H. Hobbs discussed the newly discovered Algoma meteorite. It was ploughed up in Ahnapee Township, Kewaunee County, Wisconsin, in 1887, and was recognized as a meteorite in March, 1902, when presented to the University of Wisconsin. It is an octahedral siderite weighing a little less than nine pounds. Its shape is that of an elliptical shield less than an inch in thickness. Its convex surface is fairly smooth, but exhibits strongly marked 'drift' markings consisting of radial striæ upon the front which proceed from a central flat boss to the periphery, slightly curving to form a lævo-rotatory spiral. Its concave surface is irregular and crusted. These facts indicate that the meteorite moved 'broadside on' through the atmosphere with its convex surface to the front. Casts of the meteorite in plaster may be obtained by museums and persons interested.

Professor C. S. Schlicter described the manner of flight through the atmosphere of a meteorite of the shape of the Algoma meteorite. A meteorite, discoidal in shape and possessing a rapid motion of rotation about its shortest axis, undergoes the following changes in its motion upon entering the atmosphere. The first effect of the impact is to give to the spinning body a motion of precession similar to that of a gyroscope. The next effect is the lessening of the angle of the cone described by the precessing axis, an effect entirely analogous to the 'sleeping' of a common top. In consequence of this the meteorite advances through the atmosphere with its flat side presented to the resisting medium.

Professor C. E. Mendenhall presented a paper entitled 'The Measurement of Radiant Heat.' The theory of the more important instruments for infra-red research—namely, the bolometer, thermopile, radiometer, radiomicrometer and pyrheliometer—was discussed, and examples of most of the instruments exhibited. The radiomicrometer, thermopile and pyrheliometer were shown in actual operation, and by means of the first named instrument arranged for projection the infra-red spectrum of a Nernst lamp was explored.

C. K. LEITH,
*Secretary.*

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## *DISCUSSION AND CORRESPONDENCE.*

### NORTHWESTERN AMERICA AND NORTHEASTERN ASIA.* A CRITICISM.

THE current number (48, 1902, III., pp. 49–58) of Petermann's *Mitteilungen* contains an article of some length entitled 'Nordwest-Amerika und Nordost-Asien. Geographische Wechselbeziehung,' by Capt. Fr. Immanuel, which purports to be a brief summary of the most authentic information pertaining to the geography and mineral resources of the adjacent portions of the Asiatic and North American continents. Most of the article is devoted to Alaska, and to this part I desire to offer some criticism. Capt. Immanuel, in common with many compilers, has fallen into

* Published by permission of the Director of the U. S. Geological Survey.

errors which one who had a personal familiarity with the region under discussion would have avoided. In his compilation he has not only included many statements which were based on unreliable authorities, but has totally misinterpreted the results of such investigators of the region as Dr. George M. Dawson. It is my purpose to point out some of the more glaring errors contained in this article, so that they may not become current in geographical literature.

The description of the northern Rockies, the St. Elias and Alaskan ranges, as composed of a series of volcanic peaks, hardly deserves comment, especially as they are described as a coastal fringe of volcanoes and compared with the volcanic peaks of the Japanese and Philippine Islands. A less apparent and therefore more serious blunder is the grouping together, as one range, of the Cascade, the St. Elias and the Alaskan ranges. The recent volcanoes of the Aleutian islands and the Alaskan peninsula are described as a southwesterly continuation of the volcanoes of the St. Elias and Alaskan ranges. As a matter of fact, the Alaskan range, so far as now known, is an entirely distinct feature, both geologically and geographically considered, from the belt of volcanoes which separates the Bering Sea from the Pacific ocean. The southwestward extension of the St. Elias range is found in the highlands of the Kenai Peninsula.

According to Capt. Immanuel, the glaciation of northwestern America was produced by an ice sheet which had its source in the high mountains of Greenland and moved westward across the lowlands of the northern part of the continent. He states that this ice sheet impinged on the Rocky Mountain front, and was split into two divergent glaciers, of which the southern one passed southward through the Columbian depression and into California, while the northern descended the Yukon valley. The ice sheet, during its long journey, is supposed to have ground up the auriferous quartz veins over which is passed, and their gold contents to have been deposited in the places now found in the Klondike and Nome regions. This astonishing theory is credited to Dawson and other American investigators. It is bad enough to have a statement of this nature appear in what purports to be a scientific article, but to credit it to American geologists, especially to such a thorough scientific investigator as Dawson, is the last straw.

The author in the course of the article shows himself to be as unreliable in regard to details as he is incapable of treating the broader geographic and geologic problems. For instance, he has given figures on the output of the Nome gold fields for two years, and in both cases these figures are a million or more dollars in error. For this there is no excuse, as official statements in regard to this production are in print.

The map of the Seward Peninsula which accompanies the paper, is a reproduction of one which was published in a recent report* of the U. S. Geological Survey. To this map, Capt. Immanuel has taken the liberty of adding some axes of mountain ranges of which there is no mention made in the original report. As the latter contains the results of the only surveys which have been made in the Seward Peninsula, it is impossible that there should be any authority for making these changes in the map.

There are many other misstatements which might be pointed out in this article, but I think I have given enough to show that it is an aggregation of glaring inaccuracies and faulty generalizations. Had it appeared in a lesser publication than Petermann's *Mitteilungen,* it would not have been worthy of consideration, but published as it was in one of the leading geographical journals of the world, it seemed to me that for the sake of geographic science attention should be called to its dilettante character.

Alfred H. Brooks.

### VOLCANIC DUST.

To the Editor of Science: Analysis of some mineral dust from the Martinique erup-

* Apparently through an oversight, the report, entitled 'A Reconnaissance of the Nome and adjacent Gold Fields,' was omitted from the list of authorities quoted in this article.

tion is subjoined. The sample examined fell on board of the *Alesandro del Bueno,* a vessel distant at the time about one hundred miles from the scene of the disaster at St. Pierre.

| | |
|---|---|
| Silica | 53.34% |
| Sesqui-oxides of iron and aluminium | 30.68 " |
| Calcium oxide | 10.47 " |
| Magnesium oxide | 4.12 " |
| Sulphur | 0.17 " |
| Phosphorus | trace |

The powder is highly magnetic; in all probability some of the iron present is magnetite.

F. G. WIECHMANN.

THE SUBDERMAL MITE OCCURRING AMONG BIRDS.

TO THE EDITOR OF SCIENCE: The interesting observations of Mr. Beebe (SCIENCE, May 9, 1902) require some additions, since the only author to whom he has referred gives by no means a complete statement regarding the character or occurrence of the mite. A form very similar if not identical with this has been reported a number of times: H. Garman, 1884, Leidy, 1890, and Kellicott, 1892, have noted its occurrence in various hosts in America, and it has been studied carefully by several investigators in Europe. In a paper published in *Psyche* (Volume VIII., pp. 95–100) I have given a discussion of the genus and its life history, together with a full bibliography up to that date.

It is probable that the mites found by Mr. Beebe are simply stages in the life history of some of the plumicolous sarcoptids. It may be seriously doubted whether the inferences drawn from Mr. Beebe's observations, that these mites were the cause of death of the birds noted are sufficiently well grounded. Certainly similar stages occur frequently in pigeons without apparently affecting their vitality and I should also doubt that the treatment advocated by Mr. Beebe would be likely to yield the results desired. It is altogether probable that a reduction in the number of feather mites would be accompanied by a reduction in the number of these subdermal larvæ, but the view of Mégnin is well known whereby the plumicolous sarcoptids are to be grouped as symbionts rather than as parasites by virtue of the assistance they afford to the host in keeping the surface of the skin and feathers free from débris.

HENRY B. WARD.

AN INTERESTING INVITATION.

IT is not long ago that there were people who maintained very stoutly that there existed an irrepressible conflict between religion and science. Undoubtedly there have been and there will continue to be conflicts between sciolism and religiosity. Men who are possessed of scientific truth, but lack religious or theological information of high order, may in time to come, as they have in times past, imagine that their views are antagonistic to religion; and conversely men possessed of religious truth or half truths will no doubt arise in the future, as they have in the past, who will aver that the knowledge which they have is in conflict with scientific propositions held by others. People who see only one side of a subject are given to logomachy, and if they are Scotch, or Scotch-Irish, to heated controversy. They cannot help it. In the end neither religion nor science suffer much from the squabbles which their disputatious tempers create.

It is a pleasing incident in connection with the coming meeting of the American Association for the Advancement of Science, that on March 24, 1902, the Federation of Churches of Pittsburgh, Allegheny and vicinity, held a meeting and adopted unanimously the following resolutions:

"Inasmuch as all truth is one and is divine and inasmuch as all organizations for its conservation and propagation are kindred, the Federation of Churches of Pittsburgh, Allegheny and vicinity records its pleasure in the fact that the A. A. A. S. is to hold its anniversary in Pittsburgh this year.

"In behalf of the Churches we desire a large and representative meeting here of the Seers and Prophets of Science.

"In behalf of those interested in the ad-

vancement of education and knowledge, we extend to them a hearty welcome."

It is plain from these resolutions that the clergy of these most orthodox, most order-loving, and church-going cities are not afraid of their scientific brethren. They have even gone a step further, and they extend to the members of the American Association for the Advancement of Science a cordial invitation to occupy so far as possible the pulpits of their churches on the morning and evening of June 29. It is sincerely hoped that this invitation will he heeded and that a number of the members of the Association will avail themselves of the opportunity to present to the large and intelligent audiences, which will greet them, such phases of scientific truth as may be appropriately presented before worshiping assemblies. As Chairman of the Local Executive Committee charged with making arrangements for the coming meeting, and on behalf of the clergy of the city, I desire by special request to urge those who are coming to the meeting to bring with them addresses of such a character as they may feel inclined to present, and if they will notify me in advance—which I hope they will do—of their willingness to address such audiences, we will arrange with the clergy for the assignment of such speakers to various pulpits. Scientific men as well as clergymen have 'barrels,' and I trust that not a few will open up their barrels before coming to the meeting and bring with them from their treasure houses 'things new and old' which the good people of these cities will be glad to hear.

W. J. Holland.

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## *SHORTER ARTICLES.*

### HENRI FILHOL, PALEONTOLOGIST.

By the death of Henri Filhol, French paleontology has suffered a severe loss. As a successor of the school of de Blainville and contemporary of Professor Albert Gaudry, he has rendered distinguished service, especially in his originality as an explorer of the famous deposits of the Phosporites du Quercy, terminating in his volumes published in 1877, and of the Upper Oligocene, Saint-Gérand le Puy, published in 1879. Continuing this line of research he explored the Lower Oligocene of Ronzon, publishing his results in 1880. These larger volumes together with several memoirs and a very numerous series of preliminary papers have greatly enriched our knowledge, especially of the Oligocene fossil fauna of France.

One of the most important of his discoveries was a complete skeleton of the genus *Macrotherium*, formerly established upon the claws, proving that this animal was identical with the genus *Chalicotherium*, which had been established upon the teeth. It was thus found to represent an extraordinary combination of dentition affiliated to that of the ungulates, and feet apparently affiliated to those of the edentates. M. Filhol himself was disposed to regard this animal as a connecting form; but Cope immediately perceived that it represented a new phyla, and proposed for it the name *Ancylopoda*.

During the writer's last visit to Paris, he found M. Filhol devoting his time chiefly to building up a great collection of comparative osteology, which had been almost entirely neglected since the time of Cuvier. M. Filhol expressed his purpose as follows: 'I had found it impossible to study comparative osteology in the disordered state of the collections, and I determined that I would devote my time to an entire rearrangement, so that students coming to Paris would enjoy opportunities which had been denied me.' The beautifully arranged hall, presenting all the remarkable variations, especially of the mammalian skeleton, will therefore be the monument of M. Filhol's later years.

The superb collections of fossils which he made will, it is hoped, soon be acquired by the state and placed on exhibition in the famous gallery of paleontology in the Museum of the Jardin des Plantes.

H. F. O.

### CERTAIN PROPERTIES OF NUCLEI.

In an extended series of experiments, made by shaking dilute solutions of the order of 1 per cent., .01 per cent., .0001 per cent. by weight, and a variety of solutes like HCl,

$H_2SO_4$, NaCl, $CaCl_2$, $FeCl_3$, Fe3$NO_3$, Al3$NO_3$, Ca2$NO_3$, $(H_4N)NO_3$, alum, $Na_2SO_4$, etc., and neutral organic bodies like sucrose, glucose, glycerine, urea, etc., I reached a number of new results, to one of which, in particular, I will venture to call attention here.

1. The number of nuclei produced under identical conditions of agitation varies with the violence of the agitation and the bulk of solution used, and from a theoretical point of view, particularly with the concentration of the solution and its chemical nature. Thus under given identical conditions of shaking one may get from water about 30 nuclei per cubic centimeter; from 1 per cent. $CaCl_2$ solution, 240 nuclei; from 1 per cent. $Na_2SO_4$ solution, 450 nuclei, etc.; from 2 per cent. sugar solution, 157 nuclei; from 2.6 per cent. glycerine solution, 95 nuclei, etc. So far as concentration alone goes, one may write for dilute solutions, $n=n_0+A/(\log(B/C))$, where $n$ is the number of nuclei produced per cu. cm. under otherwise like conditions, $n_0$ the number in case of infinite dilution (water), $C$ the concentration and $A$ and $B$ constants. If absolutely pure water were available, it is probable that $n_0$ would vanish. One may note that the degrees of extreme dilution effective recall the sensitiveness of electrolytic experiments. For organic neutral solutes, the number of nuclei is not only smaller as a rule, but they are characteristically fleeting.

2. The point with which I am concerned, however, is the rate at which the nuclei vanish in the lapse of time. From the marked diffusion of these nuclei, their dimensions must be comparable with molecular dimensions. Subsidence is out of the question. If, as I interpret it, the loss of nuclei in the lapse of time is due to absorption at the solid walls of the spherical receiver, one may write for the absorption velocity, $k$ (meaning that $kn$ nuclei are absorbed per square cm. per minute), $k=-(R/3n)(dn/dt)$. Computing $k$ in this way (essentially $d(\log n)/dt$), one finds from all the solutions, saline or neutral, an important general result: For the case of solutions of a few per cent. (1 to 3), $k$ is of the order of .02 to .04 cm./min., though varying from solute to solute; for the .01 per cent. solutions $k$ is of the mean order of 08 cm./min.; for the .0001 per cent. solutions, $k$ is of mean order of about 8 cm./min.; for ordinary distilled water, in glass vessels, $k$ may reach 5 cm./min., etc. I have the specific data in hand, but do not wish to weary the reader.

It follows therefore in general, that not only does the number of nuclei produced by shaking (*cæt. par.*) increase with the concentration of the dilute solution, but the apparent rate of decay of nuclei diminishes, *i. e.*, their absorption velocity decreases with the strength of the solution. For ordinary distilled water, these velocities, *if referred to three dimensions*, are already beginning to approach the ionic velocities. Again as the number of nuclei, $n$, is greater, they vanish more slowly, so that an apparent decay increasing with the density of the nucleation is out of the question. The whole, therefore, constitutes an entirely new and striking corroboration of the isolated point of view taken throughout my work.*

3. The inference is therefore tenable that the nuclei shaken out of stronger solutions are larger. Since the nuclei are produced by evaporation from a large diameter, it follows that the dimensions at which evaporation ceases at the surface of the particle are larger for the stronger than for the weaker dilute solutions. Naturally a given degree of concentration is reached in a larger globule in the former case than in the latter. The theory for the production of the nuclei here in question is thus at hand. A particle of absolutely pure water produced by shaking will either vanish by complete evaporation, or it will grow and eventually vanish by subsidence. If, however, the evaporating globule is a solution, the increment of vapor pressure at the surface of increasing convexity will gradually be compensated by the decrement of vapor pressure due to the increasing concentration of the solution. Hence there must be a critical diameter at which the increased vapor pressure due to surface tension just counterbalances the decreased vapor pressure due to concentration. This is the stable diameter of the nucleus. A smaller particle will grow because the concen-

* Compare 'Experiments with Ionized Air,' p. 92, Smithsonian Contributions, Washington, 1891.

tration effect supervenes; a larger particle will evaporate because the effect of surface tension supervenes.

4. In connection with this simple mechanism for producing stable nuclei of a startling degree of smallness by mere shaking, nuclei which may be without electrical charge, the question naturally arises whether the mechanism is not sufficient to account for nuclei in the presence of saturated vapor, in general.

Suppose therefore that such chemically powerful agencies as the X-rays, or Becquerel rays, or ultra-violet light, or the electric glow, etc., on being passed through a saturated vapor, produce in that vapor a new chemical synthesis in degree, however small (fancy the vapor pressure due to a few hundred nuclei per cubic centimeter!), soluble in the liquid from which the vapor arises. Then immediately around the new molecule there will be a region of vanishing vapor pressure. The new molecule (or ion) will therefore grow by condensing the vapor, until further growth is arrested by the decrement of vapor pressure due to diminishing convexity. In other words, the critical diameter is again reached.

C. Barus.

Brown University,
Providence, R. I.

## *QUOTATIONS.*

### THE APPLICATIONS OF ELECTRICITY IN GREAT BRITAIN.

The Institution of Electrical Engineers appointed, about a year ago, a committee to inquire into electric legislation and to recommend, if possible, such action as might assist the electrical industry. Some three weeks ago we gave the general conclusions of the committee, as embodied in a number of resolutions. Its report has now been issued, with a large amount of interesting evidence, extracts from which we publish to-day. There are practically no dissentients from the opinion that electrical enterprise is in a very backward condition in this country. The fact may be differently explained by different people, and no doubt, more than one cause may fairly be assigned. There are a few who rather glory in our backwardness, and try to persuade us that other nations have lost money by going ahead. But however the fact may be explained or regarded, it is universally admitted. In the use of electricity for traction, for lighting, and for the economical supply of power for manufacturing purposes, we are far behind other nations. So much is this the case that, when any demand arises for generating machinery and plant, it is found that there has been no previous demand of such a kind as to produce manufacturers with the requisite appliances and experience. An electric railway or tramway company has to import machinery from America or Germany, because it cannot be supplied at home, or, if supplied at all, is produced with extreme slowness. Things are, no doubt, improving in that respect, though it is not altogether agreeable to reflect that the improvement is largely due to American enterprise. The public are mostly concerned in noting the phenomena of traction and lighting. Yet it may be taken as certain that a far greater aggregate loss to the nation arises from the failure to take due advantage of the immense economy in the production and transmission of power that electricity offers when intelligently applied. The committee finds that the main cause of our backwardness is stupid and restrictive legislation, carried out by legislators having no knowledge of the subject they had to deal with, and allowing themselves to be guided by abstract political or economic theories. In other countries rulers called upon to deal with questions of this kind habitually consult men of science and frame their regulations with some regard to the special nature of the subject-matter. In other words, different forms of national intelligence are coordinated for the national good.—The London *Times*.

## *CURRENT NOTES ON METEOROLOGY.*

### MONTHLY WEATHER REVIEW.

*The Monthly Weather Review* for January (issued April 11), the first number of Vol. XXX., is somewhat changed in external appearance, and the name of Mr. H. H. Kimball as assistant editor is associated with that of Professor Abbe. There is a distinct

improvement in the quality of the paper used, but the general arrangement of the contents remains the same. This number contains the usual titles of recent meteorological papers (we may note that SCIENCE is not published in London, as stated in the *Review*, but in New York), and among the more noteworthy articles the following may be mentioned: Professor F. H. Bigelow: 'A New Barometric System for the United States, Canada and the West Indies' (see SCIENCE, March 14, 1902, 417–421), this being the first of a series of 'Studies on the Statics and Kinematics of the Atmosphere in the United States'; Albert Matthews: 'The Term Indian Summer,' an interesting historical sketch, with copious bibliographical notes; B. C. Webber: 'January Gales from the Great Lakes to the Maritime Provinces' (Mr. Webber being Inspector and Forecast Official of the Meteorological Service of Canada); an account of the work of the Weather Bureau in the West Indies; a short 'History of Meteorological Work in India'; a report on the Third International Congress on Hail Shooting, and a translation of Professor J. R. Plumandon's 'General Report on Hail Shooting,' presented to this Congress. Anyone interested in keeping up with the progress of meteorology will find the *Monthly Weather Review* indispensable. Next to the *Meteorologische Zeitschrift* it is the best general publication on meteorology now issued.

### SOME PHYSIOLOGICAL AND OTHER EFFECTS OF SUNSHINE AND SHADE.

SOME very interesting facts regarding certain effects of varying exposures to sunshine are brought out in a recent paper by M. Lugeon, professor at the University of Lausanne, entitled 'Quelques Mots sur le Groupement de la Population du Valais (Etrennes helvetiques pour 1902). A study of the principal valley of the canton, between Martigny and the Rhone Glacier, brings out some evident effects of exposure. Statistics show a population of about 20,000 on the left bank, and 34,000 on the right bank of the river. A part of this difference is doubtless due to the fact that the right bank is less steep, and hence more open to settlement, but the major part is believed by M. Lugeon to result from the difference in the exposure to sunshine. In a certain district in this same valley the slopes on both sides are about equally steep, but the population on the sunny side is about 3,000, while that on the shady side is between 700 and 800. With one or two exceptions, all the villages are on the sunny side. In fact, a certain distinction of classes results from this difference in the conditions of insolation. There is developed an aristocracy of the sun, so to speak. The people who live on the right bank are on the whole more prosperous, and better educated. They of the *Sonnenseite* look with some contempt upon the poor people on the *Schattenseite*. The village of Reckingen contains two real castes, the distinction between which rests ultimately upon the difference in exposure to sunshine.

### METEOROLOGICAL ANNUAL OF THE ROYAL BELGIAN OBSERVATORY.

*The Annuaire Météorologique* of the Royal Observatory of Belgium for 1902 is a useful publication, containing a large amount of tabular matter relating to the meteorology of Belgium for the year; meteorological conversion tables, etc., and two longer articles, one a historical sketch of meteorological work in Belgium, and the other an excellent account of the exploration of the free air, and of the results thus far obtained.

R. DEC. WARD.

HARVARD UNIVERSITY.

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### *THE WEST INDIAN ERUPTIONS AND SOLAR ENERGY.**

IN 1883, in connection with the eruption of Krakatoa, you were good enough to allow me to appeal through your quickly and widely circulated columns for early information to enable me to test an idea connected with the spread of the glorious sunsets round the world which followed the event.

Because the terrible catastrophies in Martinique and St. Vincent occurred at a well de-

* A letter addressed to the editor of the London *Times* by Sir Norman Lockyer.

fined sunspot *minimum* I was led to inquire whether similar coincidences were to be traced in the past. I did not know then, but I know now, that Wolf, exactly half a century ago, had suggested a connection between solar and seismic activity; in his time, however, the record of solar changes was short and imperfect.

In my own inquiry I have used our most recently compiled tables, which are now complete for the last 70 years, and I have only considered seismic disturbances within that period. I find beyond question that the most disastrous volcanic eruptions and earthquakes, generally occur, like the rain pulses in India, round the dates of the sunspot *maximum* and *minimum*. More than this, the 35-year solar period established by Dr. Lockyer, which corresponds approximately with Bruckner's meteorological cycle, can also be obviously traced, so that, indeed, the intensification of the phenomena at the *minimum* of 1867 is now being repeated.

In 1867, Mauna Loa, South America, Formosa, Vesuvius were among the regions involved; in the West Indies it was the turn of St. Thomas. The many announcements of earthquakes in the present year before the catastrophe of St. Pierre will be in the recollection of everybody.

In the *maximum* in 1871-72, to name only West Indian stations, Martinique first and then St. Vincent followed suit; in the next *maximum*, in 1883 came Krakatoa.

At Tokio, in a country where the most perfect seismological observatories exist, we find that at times near both sunspot *maxima* and *minima* the greatest number of disturbances have been recorded.

Very fortunately, the magnificent work of the Indian Meteorological Department enables us to associate the solar changes with pressures in the tropics, and obviously these pressures have to be taken into account and carefully studied.

This, sir, brings me to the point of this letter, which is, through your kindness, to ask from meteorological observers in the West Indies and the surrounding regions the favor of copies of their barometrical readings, showing the departures from the local means for the two months preceding the eruption at St. Pierre. In this way one or two years may be saved in getting at the facts.

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## *SCIENTIFIC NOTES AND NEWS.*

At the annual meeting of the American Academy of Arts and Sciences, held on May 14, it was voted to award the 'Rumford Premium' to Professor George Ellery Hale of the Yerkes Observatory, 'for his investigations in solar and stellar physics, and in particular for the invention and perfection of the spectro-heliograph.' It was also voted to appropriate the sum of $750 from the income of the Rumford Fund to be expended for the construction of a mercurial compression pump designed by Professor Theodore W. Richards and to be used in his research on the Thomson-Joule effect. An appropriation from the Rumford Fund was also made to Professor Arthur A. Noyes in aid of his research upon the effect of high temperatures upon the electrical conductivity of aqueous solutions.

Dr. Angelo Heilprin, of Philadelphia, and Mr. George Kennan are among those who are engaged in studying the volcanic eruptions in the Lesser Antilles. They, as well as Dr. R. T. Hill, according to the reports in the daily papers, have made a thorough examination of the conditions in Martinique, having explored that the Government will defray the expenses.

The Paris Academy of Sciences will send a scientific mission to investigate the volcanic eruptions in the Lesser Antilles. The mission will probably sail on June 9. It is understood that the Government will defray the expense.

An expedition to study the volcanic eruptions in the West Indies is also planned by Great Britain under the auspices of the Royal Society. It is expected that Dr. Tempest Anderson and Dr. Flett, of the Geographical Survey, will be members of the party.

A scientific Commission consisting of Dr. G. C. Low, Dr. C. Christy and Dr. Castelani has been sent to Uganda by the Royal Society for the purpose of investigating sleeping sickness.

MR. C. CROSSLAND and Mr. J. S. Budgett have received grants for zoological research in Africa from the Balfour fund of Cambridge University.

CAPT. J. S. PRATT, of the U. S. Coast and Geodetic Survey, is preparing for his annual cruise in northern waters on the United States steamer *Patterson*.

FOREIGN exchanges state that Professor Rudolf Virchow is now going through a 'cure' at Teplitz-Schonau, where he is under the care of Dr. Hirsch. He is able to walk about with support, sometimes using only one crutch. He is regaining power over the injured limb, being able to lift the left leg so as to place it across the right knee. His general condition is also much improved.

DR. S. KIMURA, surgeon inspector of the imperial Japanese navy, is at present in this country, where he will spend three months examining the medical and hygienic arrangements of our navy.

THE University of Cambridge will on June 10 confer the degree of LL.D. on Mr. F. S. R. Bell, of the Canadian Geological Survey.

THE prize of the Otto-Vahlbruch foundation at Hamburg has this year been awarded to Dr. Ludwig Boltzmann, professor of physics at the University of Leipzig. The value of the prize is about $2,400.

THE Rolleston Memorial Prize, awarded at Oxford University for original research in morphology, has been given to Mr. Francis J. Cole, of Jesus College.

SIR WILLIAM TURNER THISTLETON DYER, director of the Kew Botanical Gardens, has been appointed botanical adviser to the secretary of state for the colonies.

THE degree of M.A. has been conferred by Oxford University on Andrew L. Herbertson, Ph.D. (Freiburg in B.), lecturer in regional geography, and on Henry N. Dickson, B.Sc., New College, lecturer in physical geography.

CAMBRIDGE UNIVERSITY has granted the degree of M.A. (*honoris causa*) to Mr. T. H. Middleton, professor of agriculture.

ON February 15 the Russian Medical Society celebrated the hundredth anniversary of the birth of its founder, Dr. Fedor Inosemzeff, who died in 1869. Dr. Inosemzeff was professor of surgery in the University of Moscow till his death.

A MEMORIAL erected by Edward Longstreth, of Philadelphia, to John Fitch, who is said to have been the first to apply steam to the running of a boat, has been erected in Warminster, Pa. It bears the inscription: "John Fitch here conceived the idea of the first steam-boat. He ran a boat with side-wheels by steam on a pond below Davisville in 1785. Bucks County Historical Society."

WE have already noted the unveiling of a bronze tablet at Lafayette College in memory of the late James H. Coffin. The inscription reads as follows: "In memory of James Henry Coffin, LL.D. Long a main-stay of Lafayette College, professor of mathematics, natural philosophy and astronomy, 1846-1873; vice-president and college treasurer, 1863-1873. A tireless teacher and administrator, an officer of the church, a friend of the slave. A member of the National Academy of Sciences, author of 'Winds of the Globe.' He annexed the atmosphere to the realm of science, and searched the highways of the winds and the paths of vagrant storms. Born in Williamsburg, Mass., September 6, 1806; died in Easton, February 6, 1873. The Class of 1866 has erected this tablet."

PROFESSOR ADOLF KUSSMAUL, the eminent German pathologist, who recently celebrated his seventieth birthday, died on May 27. Dr. Kussmaul is eminent for his work on aphasia and other forms of nervous disease.

MR. G. C. HUBBARD, assistant in the department of chemistry, Columbia University, died on May 26. Mr. Hubbard graduated from the School of Applied Science in 1900.

MR. ANDREW CARNEGIE has promised to duplicate all subscriptions up to $7,500 to the Hugh Miller Centenary Memorial.

MRS. COLLIS P. HUNTINGTON has given the sum of $100,000 to the General Memorial Hospital for the Treatment of Cancer and Allied

Diseases, New York, the income to be used for pathological research.

Mr. Edmund Oldfield, F.S.A., of Rushmore, Torquay, Honorary Fellow of Worcester College, Oxford, who died on April 11, last, bequeathed to the chancellor, masters and scholars of the University of Oxford his cabinet of antiquities, and various specimens of Greek, Roman and Etruscan art in marble, bronze and terra cotta, and he desired that they should be placed in the Ashmolean Museum and known as the 'Oldfield Bequest.'

The Royal Academy of Medicine of Belgium offers a prize of 800 francs for research on the anatomical relations of the neurons to each other.

The Royal Society held the first of its annual conversaziones on May 14, with, as appears from the official catalogue, a very interesting exhibit of new apparatus and methods. Of most general popular interest were perhaps the exhibits in color photography by Dr. R. D. Roberts, Sir H. Trueman Wood and Messrs. Samger Shepherd and Company. The photographs showing geological formations and photomicrographs of stained sections of tissues are of considerable scientific interest as giving results free from the personal equation of the artist. As has been usual in late years X-ray photographs appear to have been a prominent part of the exhibition. Other exhibits in physics were a new type of chronograph, in which the pens are moved instead of the drum, by Mr. R. L. Mond and Dr. Wilderman; the film structure of metals by Mr. George Bailey; an improved coal calorimeter by Mr. W. Rosenheim, and kites for meteorological purposes by Mr. W. H. Dines. The zoological exhibits included fossil mammals from Egypt, recently obtained by the Natural History Museum; the parasites discovered by Dr. A. Tylor in the blood of cattle in South Africa and by Mr. Everett Dutton in human blood, where symptoms occurred resembling those suffered by animals when bitten by the Tsetse fly. Photographs of the nebula surrounding Nova Persei were exhibited by Professor Hale, of the Yerkes Observatory.

The amount proposed to be expended in three years by Great Britain on North Sea fishery investigations, as the result of the Stockholm and Christiania Conference (including the share of the cost of the central bureau) is £42,000.

The American Congress of Tuberculosis is meeting this week in New York City. Among those expected to take part are Dr. Daniel Lewis, head of the Health Department of the State of New York; Dr. E. J. Barrick, of Toronto; Dr. J. J. Kinyoun, of Glendola, Pa.; Professor J. G. Adami, of McGill University, and Dr. D. E. Salmon, chief of the Bureau of Animal Industry, Department of Agriculture.

The American Institute of Electrical Engineers held its nineteenth annual meeting on May 20. Mr. Charles F. Scott was elected president to succeed Mr. Charles P. Steinmetz. It was reported that during the year the number of members had increased by 239 and the assets of the institute by nearly $15,000.

At the recent annual meeting of the Louisiana Society of Naturalists the election of officers for the ensuing year resulted as follows: *President,* W. R. Dodson; *First Vice-President,* E. M. Hudson; *Second Vice-President,* Miss Grace King; *Third Vice-President,* Ed. Foster; *Secretary,* R. S. Cocks; *Treasurer,* G. R. Westfeldt; *Executive Committee,* A. Richards, R. Rordam, Dr. Martin Feingold.

Plans have been prepared for the erection of a bacteriological laboratory in Washington, under the control of the Marine Hospital service. We noted last year the act of Congress appropriating $35,000 for this purpose, and setting aside five acres of ground from the reservation now occupied by the Naval Museum of Hygiene.

A central seismological laboratory has been established at Strassburg and placed under the charge of a board including Professors Becker (Strassburg), Credner (Leipzig), Futterer (Karlsruhe), Gerland (Strassburg), Helmert (Potsdam), A. Schmidt (Stuttgart),

Wiechert (Göttingen), and von Zittel (Munich).

THE monthly general meeting of the Zoological Society of London was held on May 23, Dr. Henry Woodward, vice-president, in the chair. It was stated that there had been 173 additions made to the Society's menagerie during the month of April, among which special attention was directed to two pairs of the beautiful grey teal (*Querquedula versicolor*), of the Argentine Republic, obtained by purchase. After the proceedings of the usual monthly general meeting had terminated Professor J. Cossar Ewart delivered a lecture on 'Horses and Zebras.'

MR. EADWEARD MUYBRIDGE writes to the editor of the London *Times* as follows: In the new volumes of the 'Encyclopædia Britannica' is reproduced in the articles 'Egyptology' a tablet of Mena dating from the first dynasty, or about 4700 B.C., and is the oldest written sentence yet discovered. In 'A History of Egypt, by W. M. Flinders Petrie,' the author, referring to the Egyptian artists of the fourth dynasty, says: 'They did not make a work of art as such, but they rivalled nature as closely as possible.' Two figures—a bull and a deer—on the tablet of Mena afford a remarkable confirmation of the professor's statement, in regard to the knowledge and expression of motion by the sculptor of this age. A bull striving to attain his utmost speed is represented in a phase of movement, which after a lapse of 66 centuries is reproduced in a photo-engraving illustrating some consecutive phases in the stride of a horse, published in the 'Century Dictionary' under the heading of 'Gallop,' and in the 'Standard Dictionary' in its definition of 'Movement.' The phase employed by the Egyptian artist has been, until recent years, very rarely used in art; the nearest approach to it that I can at this moment recall is in a fresco painting on the walls of the Campo Santo at Pisa, supposed to have been executed at Pisano. It, like the Mena tablet, illustrates a phase of the transverse gallop—a system of motion adopted by the horse, the ox, and the greater number of animals, whether single toed, cloven or soft-footed, when they exert their utmost power to attain their highest speed. In the lowest line of figures on the tablet is a deer, evidently jumping over an obstacle. The animal is represented with all its legs, flexed, in pairs, under its body. A precisely similar phase may be found in a series, in the library of the British Museum, demonstrating a jump which sometimes takes place in the rotary gallop of the deer, which system of motion is always used by the deer and also by the dog, when from caprice or necessity they endeavor to make rapid progress. This distinctive method of galloping was unknown, and, indeed, unsuspected by us moderns, until revealed by photographic investigation of animal locomotion; but it was apparently well known to the early artists of Egypt.

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## *UNIVERSITY AND EDUCATIONAL NEWS.*

YALE UNIVERSITY has received for the Sheffield Scientific School a new building for mineralogy, geology and physiography. The donor and the value of the building are not announced, but it is to be known as Kirtland Hall, in memory of the late Professor Jared Potter Kirtland. Professor Kirtland, who was a Yale graduate of the class of 1815, and died in 1877, was professor of the theory and practice of medicine in Ohio Medical College and in Western Reserve College. He was a member of the National Academy of Sciences, and served on the geological survey of Ohio. Plans for the new building show a four-story structure of 95 feet front and 65 feet depth. It will be of plain red brick, with white marble and other stone trimmings. Designs were made by Kirtland Kelsey Cutter of Spokane, a great grandson of Professor Kirtland. The main floor will be devoted to mineralogy, the second floor to inorganic and physical geology, the third to physical geography and physiography, and the basement to mining.

A NEW building, chiefly for surgery, is to be erected for the Johns Hopkins Medical School at a cost of $100,000.

Boylston Hall, the chemical laboratory of Harvard University, has been much overcrowded during the last two years. There is about to be added a wing 83 x 33 ft. which will be used by the elementary classes until a new building is constructed.

Mr. Robert S. Brookings and others have presented to Washington University a building which was erected for the use of the St. Louis Club. This building will now be used for the Washington University Club, an organization including professors, male graduates and students of Washington University. The annual dues will be $5.00. The Club will also provide board for students whose homes are not in the city of St. Louis. An effort will be made to bring representatives of all departments of the University together in this club, to afford good board at reasonable prices, and make the club a home for the graduate and undergraduate students of the University.

The late Henry S. Morton, president of the Stevens Institute, has bequeathed his scientific instruments to the institute.

Cushing Academy at Ashburnham, Mass., has received a legacy estimated at from $200,000 to $400,000 by the will of Jacob H. Fairbanks of Fitchburg. The town of Ashburnham receives $40,000 for a memorial town hall.

In the abstract of the accounts recently submitted to Convocation, the total benefactions at Oxford University last year are announced to be £2 13s. 4d., an increase of 8d. over the previous year.

The U. S. Military Academy at West Point will celebrate its centennial next week. The president of the United States will be present, and the leading universities and scientific schools will be represented by their presidents.

Hereafter Latin will not be required as part of the matriculation examination of the University of London. Logic, drawing, advanced mathematics and geography are added to the subjects that may be elected.

Several alterations in the regulations for the Natural Sciences Tripos at Cambridge University have been passed, including the proposal that, in arranging the class list for the second part of the examination, the examiners may place a candidate in the first class for proficiency in one of the following branches of science: chemistry, physics, mineralogy, geology, zoology and comparative anatomy, human anatomy, physiology. This was opposed but carried by two votes, the numbers being—placet 75, non-placet 73. Under the old regulations no candidate was placed in the first class for proficiency in one subject unless he had a competent knowledge of some other subject.

The following degrees were conferred at the University of Colorado on June 5: M.A. 6, M.S. 2, B.A. 3, B.S. 8, B.Ph. 19, B.S. in engineering 8, LL.B. 12, M.D. 13. A new department of mechanical engineering has been added to the engineering school.

Dr. John Dewey, professor of philosophy at the University of Chicago, has been appointed to the office of director of the School of Education, made vacant by the death of Col. Francis W. Parker.

The Rev. Dr. G. P. Denton, president of the Upper Iowa University, has been elected president of Miami University, Oxford, Ohio. The Rev. Norman Plass, of Williamstown, Mass., has been elected president of Washburn College, Topeka, Kansas.

Arthur Byron Coble, fellow in mathematics in the Johns Hopkins University, has been appointed to the chair of mathematics in the University of Missouri.

Dr. Josiah Royce, professor of philosophy at Harvard University, will deliver the commencement address at Iowa College, Grinnell, at which time the new president, Dr. E. F. Bradley, will be installed.

Professor Menschutkin, who holds the chair of chemistry in the University of St. Petersburg, and Professor van Geer, who holds the chair of mathematics in the University of Leiden, have retired from the active duties of their professorships.

Mr. T. B. Wood, of Gonville and Caius College, has been appointed reader in agricultural chemistry at Cambridge University.